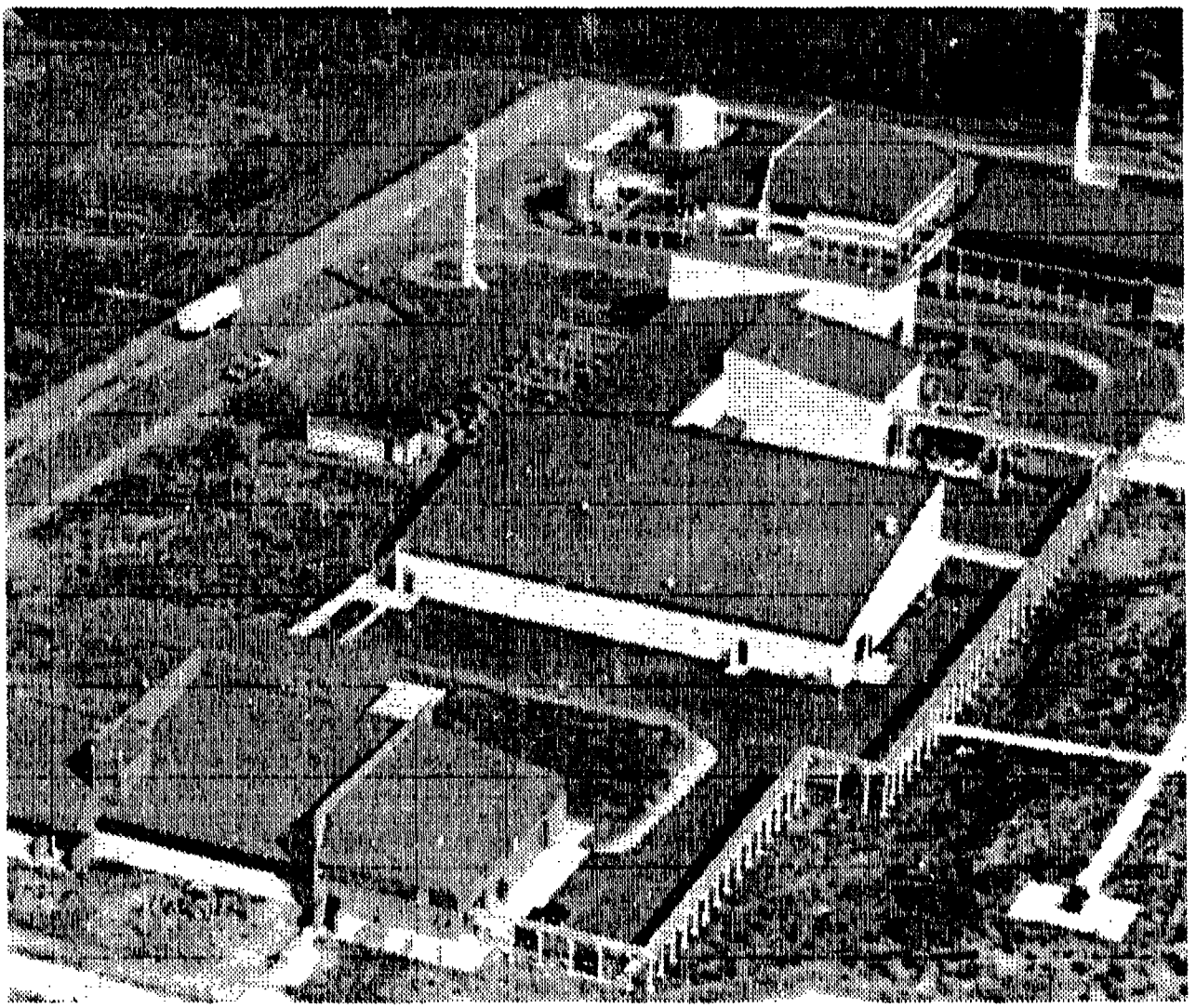
(2)

The Impact of Toxic Agent Training on Combat Readiness



March 1992

"But I have to tell you one of my biggest concerns from the outset was the psychological impact of the initial use of chemical weapons on the troops. If they fight through it, then it is no longer ever going to be a problem. But if it stops them dead in their tracks and scares them to death, that is a continuing problem. And that was one of the concerns we had all along."

General Schwartzkopf Senate Hearings, May/June 91

"Then and now, they (soldiers and leaders) wholeheartdly value the opportunity to train with actual agents, real detectors/alarms and real decontaminants.

The presence of CDTF trained soldiers in every company of the Division directly improves our combat readiness. These soldiers have geat confidence that their equipment works. Your training program is right on target."

Major General McCaffrey, CG, 24th ID in letter to BG Orton, 2 Mar 92

A reporter interviewed a soldier who was arriving home from Desert Storm. The reporter asked the soldier, "Were you worried about chemical warfare?" The soldier promptly replied, "Not a bit. We were ready for it."

CNN Report of a returning 24th ID Soldier

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An assessment of the impact of live/toxic chemical agent training on combat readiness. Impact is based on USACMLS task force review of current and projected simulant technology, analysis of feedback from soldiers in grades of PV1 to General, input from Desert Storm veterans, as well as Lessons Learned from the use of toxic chemicals in World War I. Conclusions reached are: (1) Live agent training is directly linked and contributes significantly to combat readiness. (2) There is a significant quantifiable difference in soldier confidence and credibility as a result of training with live agents versus simulant training. (3) Our current level of proficiency and readiness cannot be achieved through use of simulants alone. (4) Army must sustain live agent training in the CDTF if we are to maintain an NBC trained and ready Army.

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DEPARTMENT OF THE ARMY
US ARMY CHEMICAL SCHOOL
FORT MCCLELLAN, ALABAMA 36205-5020

REPLY TO
ATTENTION OF

ATZN-CM-M (340)

MEMORANDUM FOR Commanding General, U.S. Army Training and Doctrine Command, ATTN: DCST, Fort Monroe, VA 23651-6000

SUBJECT: Requirement for Toxic Agent Training

1. We have taken a fresh look at the need for live/toxic agent training as requested by the Department of the Army staff. The report of our findings and conclusions is attached. After reviewing this report and the lessons learned from Desert Storm, I am more convinced than ever that toxic agent training for Chemical Corps soldiers is absolutely essential.

2. Key components of NBC readiness are confidence in our equipment, doctrine and training, and the credibility of the Chemical Corps soldier assigned to each unit in the Army. In the First World War, it was a lack of confidence in our equipment, inadequate training, and fear of the unknown that caused instances of green units fleeing the battlefield at the first sign of gas warfare. On other occasions, veteran units fought on through days of constant gas attacks. While it was possible to learn by experience against those first generation chemical agents, that is not possible with the wide array of highly lethal agents produced in the world today. As Trevor Dupuy noted in his study of "Soldier Capability--Army Combat Effectiveness, Historical Combat Data and Analysis":

> "... unit training under realistic conditions, and/or combat experience, is extremely important to combat success..." and "... panic in combat is a function of the group environment rather than of the individual's personal qualities, but the action of a few individuals can start or stop it..."

3. Training with live chemical agents in the CDTF gives each unit a "veteran" who has been there and can credibly share his confidence in our equipment, doctrine and training. As Major General McCaffrey notes in his memo transmitting survey results from the 24th Infantry Division leaders who went through the CDTF, "The presence of CDTF trained soldiers in every company of the Division directly improves our combat readiness." The net result in Desert Storm was an NBC trained and ready Army that, by its readiness, deterred a chemical war.

ATZN-CM-M
SUBJECT: Requirement for Toxic Agent Training

4. The requirement for toxic agent training must be assessed from a broader, long-term perspective. A national consideration, often overlooked, is the reliance of EOD specialists, Technical Escort specialists, and arms control inspectors on live agent training. These soldiers and civilians face an even more constant threat of encountering a toxic environment on a day to day basis. Their mission is to conduct or verify the safe storage, transportation, and demilitarization of chemical agents. EOD and Technical Escort soldiers are expected to react promptly and correctly to contain the danger from an incident/accident. Correct, quick -veteran- response can mean the difference between a minor incident quickly contained and a major accident resulting in disaster.

5. As an Armor soldier must actually fire on tank table VIII and not just use simulators, as airborne soldiers must actually jump out of aircraft and not just jump off towers, as all soldiers must qualify with ball ammunition during basic rifle marksmanship and not just use the weaponeer--so must Chemical Corps soldiers certify their skills with live agents and not just simulants. When I know that our soldiers have seen those drops of deadly nerve agent and been able to detect, identify, and decontaminate them safely, then I am able to certify them as proficient Chemical Corps soldiers. Further, I would emphatically state that all leaders, regardless of branch, should possess the knowledge and confidence inherent in the "CDTF experience" to carry forward into battle.

6. The need for, and benefit of, live agent training is amply documented in the attached report. The real question here though is not the value of CDTF training. It is when and where do you want live agent training to begin? We can begin training with live agents during initial entry training at the CDTF, or we can begin on the first day of the next war on some distant battlefield. The choice, and I believe the answer, is clear. Given the proliferation of chemical weapons in the world today, we must retain the CDTF and live agent training as one of the keys to a trained and ready Army.

Robert D. Orton

ROBERT D. ORTON
Brigadier General, USA
Commandant

CF:
CG, CAC
CG, CASCOM

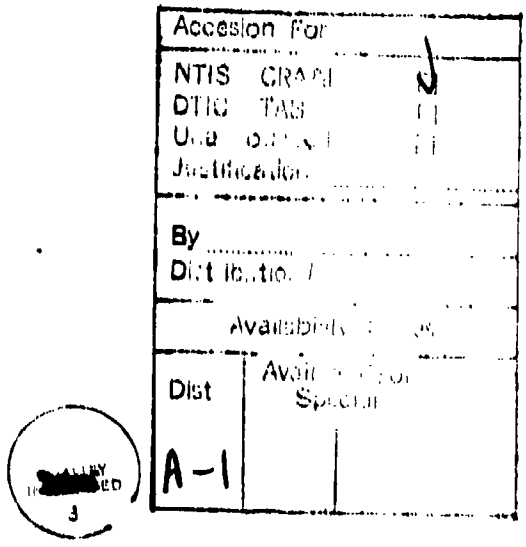
THE IMPACT OF

TOXIC AGENT TRAINING ON

COMBAT READINESS

FINAL REPORT

MARCH 1992



THIS REPORT HAS BEEN REVIEWED AND APPROVED BY THE COMMANDANT, AND REPRESENTS THE OFFICIAL POSITION OF THE U.S. ARMY CHEMICAL SCHOOL.

SUMMARY

This report is an assessment of the impact of live/toxic chemical agent training on combat readiness. The report is based on our review of current and projected simulant technology, analysis of feedback from soldiers in the grades of PV1 to General, input from Desert Storm veterans, as well as lessons learned from the use of toxic chemicals in World War I.

Based on this analysis we conclude that:

- Live agent training is directly linked, and contributes significantly, to combat readiness.
- There is a significant quantifiable difference in soldier confidence and credibility as a result of training with live agent versus training with simulants. This increase in confidence and credibility equates directly to an increase in readiness.
- Our current level of proficiency and readiness cannot be achieved through use of simulants alone.
- The Army must sustain live agent training in in the Chemical Defense Training Facility (CDTF) if we are to maintain an NBC trained and ready Army.

ANALYSIS OF THE IMPACT OF TOXIC AGENT TRAINING ON COMBAT READINESS

FINAL REPORT

1. Introduction

a. The Chemical Defense Training Facility (CDTF) began operations with toxic chemical agents in March 1987. The opening of this facility represented the culmination of 14 years of effort by the Chemical Corps to resume training with toxic chemical agents. The period of time between 1973 and 1987 represented the only period in the history of the Chemical Corps that no live agent training of its soldiers was conducted. That same period of time represented the nadir of NBC defense preparedness of the U.S. Army.

b. In February 1992 The Department of the Army requested that Training and Doctrine Command (TRADOC) and the U.S. Army Chemical School (USACMLS) reassess the need for toxic agent training. That need was to be assessed in terms of:

(1) What value does the current live agent training afford the Army in terms of readiness--is there a linkage?

(2) Is there a significant, tangible/quantifiable difference between training with live agents in terms of readiness vs training with simulants?

(3) Can the current level of proficiency and associated level of readiness be achieved through use of simulants vs live agents?

(4) Should the Army sustain the CDTF?

c. The above outlined effort was directed on 18 February 1992 with a response due to the Department of the Army by 15 March 1992.

2. Methodology

a. Readiness

(1) Field Manual 25-101 states "Training is the cornerstone of readiness and the basis for credible deterrence and capable defense." Field Manual 25-100 states "Training programs must result in demonstrated tactical and technical competence, confidence, and initiative in our soldiers and their leaders." The key words in these definitions as they apply to the CDTF are confidence, competence, and credibility. Demonstrated improvement in one or more of these factors should then be directly linked to readiness.

(2) We conducted a review of the Walter Reed Study titled "Stress, Confidence, Performance, and Credibility Produced by Toxic Agent Training at the Chemical Decontamination Training Facility." This study was conducted at the request of the Undersecretary of the Army to ensure that toxic agent training was not too stressful and to determine what training benefit resulted from toxic agent training. We also reviewed the doctoral dissertation titled, "The Effects of Using Chemical Agents in Training on the Confidence and Proficiency of the Chemical Corps Advanced Individual Training Soldiers," by Dr. Paula Smith, USACMLS.

(3) In as much as the data for both of the above mentioned studies was taken in 1987 we undertook two other analytical efforts in this area. First we reviewed post CDTF training questionnaires administered to a wide range of student populations for 1991. Given the less than optimum design of the questionnaire, only student confidence could be judged. A second questionnaire was designed and administered to soldiers (COL-SPC) from the 24th Infantry Division who participated in CDTF training after returning from Operation Desert Storm. This instrument was designed to assess the impact of CDTF training on soldiers confidence and credibility.

(4) Lessons learned from Operation Desert Storm were also included in this analysis.

b. Simulants

(1) We conducted a thorough review of simulant literature, ongoing simulant use, and requirement documents for new simulants for NBC training. Shortfalls in present day simulants were identified. Gaps that will remain after development/fielding of the new Persistent Chemical Agent Simulant/Chemical Agent Disclosure Solution (PCAS/CADS) were also examined.

(2) Simulant vis a vis actual agent training effectiveness was also addressed in the Walter Reed Study referred to in para 2.a.(2) and in Dr. Smith's dissertation referred to in the same paragraph. The results from these studies are included in our analysis.

(3) We reviewed the Combined Arms in a Nuclear and Chemical Environment (CANE) tests to determine if, under realistic field conditions, training with simulants builds soldier confidence in either their performance or their protective gear.

c. Value Added

The CDTF is a unique facility that allows soldiers of all ranks to use real detectors, monitors, alarms, decontaminants, and decontamination kits/devices with toxic agents. Chemical defense tactics, techniques, and procedures (TTP) are used daily.

Shortfalls in TTPs and equipment have been identified and corrective actions taken. These shortfalls/lessons learned have been captured and their impact assessed.

d. Population Trained.

The CDTF is not solely a Chemical Corps or even Army asset. This facility provides essential training for EOD and Technical Escort specialists, State Department and OSIA arms control experts and Marine Corps and Navy Chemical warfare personnel. A wide array of foreign nationals train in this facility in conjunction with attendance at professional development courses. One nation, Germany, sends their Chemical Corps soldiers TDY to Fort McClellan solely to train in live agent. A similar program is envisioned for the United Kingdom. A listing of the student population trained in the past 5 years is contained at Appendix J.

3. Discussion

a. The Chemical Defense Training Facility (a.k.a. The Chemical Decontamination Training Facility (CDTF)) is used to provide live/toxic agent training to Chemical Corps initial entry training (IET) soldiers, noncommissioned officers, and officers. In addition to these soldiers the CDTF is also used to provide live agent training to EOD specialists, State Department Arms Control specialists, On-Site Inspection Agency (OSIA) inspectors, USMC, USN; and chemical specialists from the German Army. Future plans call for the addition of chemical specialists from the United Kingdom. In essence, these external agencies vote for the effectiveness/criticality of live agent training with the funds spent on TDY and to reimburse the School.

b. This population includes personnel who are potentially exposed to toxic agents on a day to day basis. This potential exposure results from our requirement to safely store, transport, and destroy chemical munitions and to respond to any accidents involving those munitions. Chemical Corps soldiers, technical escort specialists, and explosive ordnance disposal specialists all train with live chemical agents in the CDTF to ensure their proficiency in handling live chemical munitions. Prompt, correct reaction by those specialists can make the difference between a minor incident quickly contained and a major accident resulting in disaster. The readiness of these personnel is indeed tied directly to training with live agent.

c. The majority of appendices included with this report deal mathematically with questionnaires administered to soldiers who trained in the CDTF. While statistics do tell a portion of the story, they do not tell the whole story. Consequently, we have added an appendix that provides an anecdotal summation of the value of the CDTF. Quotations used therein were taken from generals and privates, active and reserve components. All express the value of live agent training most eloquently albeit not quantifiably.

d. Salient characteristics and capabilities of the CDTF are summarized in Appendix A. Also included in this appendix are the tasks, conditions and standards taught to Chemical Corps one station unit training (OSUT) soldiers. Different tasks are, of course, taught to different categories of students.

4. Results.

a. All studies to date confirm an increase in soldier confidence after training in the CDTF.

b. All studies to date confirm that toxic/live agent training is more stressful than simulant training.

c. Soldiers (COL thru SPC regardless of branch/MOS) who participated in extensive NBC training as part of Desert Shield and later went through the CDTF report a significant increase in confidence after going through live agent training.

d. Both the Walter Reed Study and the analysis of 24th Infantry Division responses support the contention that CDTF training provides soldiers who undergo the training with increased credibility at unit level.

e. The studies conducted to determine if "proficiency" increased as a result of CDTF training (Walter Reed and Dr. Smith's dissertation) showed no correlation between CDTF training and proficiency. (Note that proficiency was measured in a written exam administered before the CDTF training took place.)

f. The "value added" from live agent training resulted in the identification of major issues/problems associated with current tactics, techniques, and procedures (TTPs). Correction of these issues/problems resulted in the safer, more effective use of chemical agent monitors, decontamination kits, and detection/identification devices.

5. Conclusions

a. Toxic/live agent training is more stressful and builds confidence more effectively than training with simulants.

b. A soldier who has trained with toxic agents is a more credible expert/trainer than a soldier who has trained with simulants alone.

c. No existing simulant adequately replicates a chemical agent physically, physiologically or psychologically for training purposes.

d. Live/toxic agent training, by increasing the confidence and credibility of Chemical Corps soldiers, increases the readiness of those soldiers and of their units. Our current level of NBC readiness cannot be sustained without live agent training.

e. Despite its use by a multitude of services and governments, the CDTF is underutilized with less than 5,000 personnel trained in the facility in FY91.

6. Recommendations

a. Retain live agent training as the cornerstone of the NBC readiness of the Army.

b. Add live agent training at the CDTF to the Precommand Course for all LTCs and COLs scheduled for TOE commands.

7. Study Participants

Colonel Robert J. Coughlin	AV 865-6564
Doctor Paula S. Smith	AV 865-5071
Captain Stephen L. Healy, III	AV 865-6235
Captain Michael O. Kierzewski	AV 865-4111
Mister Dallas H. Smith	AV 865-3877

APPENDIXES

A. CDTF Characteristics and Capabilities

B. Walter Reed Army Institute of Research Study entitled: "Stress, Confidence, Performance, and Credibility Produced by Toxic Agent Training at the Chemical Decontamination Training Facility" (1989)

C. Presentation to ADPA Conference 4 December 1991, Summation of Doctoral Dissertation, Smith, [illegible]la S. "The Effects of Training with Lethal Chemicals on Job Proficiency and Job Confidence"

D. Analysis of FY91 CDTF Student Questionnaires

E. Analysis of 24th Infantry Division Questionnaires

F. CDTF Anecdotal Summary

G. Simulant Analysis

H. Desert Shield/Storm Lessons Learned

I. CDTF Lessons Learned

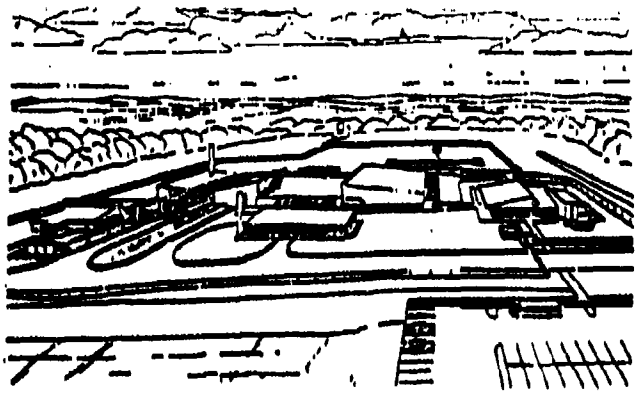
J. CDTF Student Population

K. Analysis of Senior Commanders' Course Questionnaires

APPENDIX A

CDTF Characteristics and Capabilities

CHEMICAL DEFENSE TRAINING FACILITY (CDTF)
CAPABILITIES AND CHARACTERISTICS



PURPOSE:
- -Realistic Training/Experience
- -Instill Confidence/Credibility
- -Demonstrate Protection (MOPP 4)
- -Promote NBC Readiness/Awareness

FACILITY:
- -Construction Completed 1987 Cost $14.2 M; 58,500 Sq Ft; 17.2 Acres
- -Est $20-25 M Replacement Cost
- -State/Federal Approval (EIS, permits) required for new sites

CONSTRUCTION MILESTONES:
- -Feb 81 Permit Process Began
- -5 Sep 83 Started Construction
- -8 Sep 86 Finished Construction
- -2-6 Feb87 Preoperational survey
- -19 Feb 87 Toxic Operation
- -2 Mar 87 1st Student Trained

TRAINING:
- -6,000 Students/Year - Goal 10,000/Year
- -36,400 Max Treining Capacity - 700/week X 52 Weeks
- -Officer (2LT - General Officer)
- -NCOs (E5 - E9)
- -Other Services: Navy/Marine Corps/Air Force/Merchant Marine
- -Other Government Agencies
- -Foreign Services
- -CDTF training continuously modified as doctrine/equipment changes
- -20,000 students trained to date

COSTS:
- -Training Cost/Student - $575.86
- -Annual CDTF Budget - $2.47 M
- -(includes cost of medical, fire, security support, salaries and expendables)

SAFETY/ENVIRONMENTAL COMPLIANCE:
- -CDTF boasts a perfect safety and environmental record since opening in 1987.
- -Negative pressure system/ continuous air monitoring
- -Incinerator - pollution abatement
- -Wastewater treatment/sampling
- -Holding areas for DS-2 items
- -3X holding area for contaminated material
- -Require site decon to 5X level at est cost of $30-40 M or to 3X and keeping the facility under government control - Post closure
- -State & Federal inspections: Average six/year
- -DA Inspections: (IG/USANCA/DA/ Safety/AEHA)
- -Medical/Environmental Records maintained for 40 yearr

PHYSICAL SECURITY:
- -9 DOD Civilian Guards and MP augmentation
- -24 Hr/Day Manning
- -Response Force: Augmentees as needed
- -Periodic Vulnerability Analysis

CHEMICAL SURETY:
- -Full compliance with AR 50-6 and 190-59 (Fence, Lighting, Cameras, anti-intrusion Devices, etc.)
- -Maximum total quantity of agents authorized on hand - 1 liter
- -Agents VX and GB (Nerve) produced/decontaminated on site
- -Approved by DOD Explosive Safety Board; periodic inspections by: DDESB, EPA, State of Alabama, DAIG, Chemical Surety Team

STAFF:

27	Military
13	DA Civilians
9	DA Civilian Guards
3	Medical DA Civilians
14	Maint. Contractor Civilians
66	Total

INITIAL ENTRY TRAINING
TASKS, CONDITIONS, STANDARDS
DAY ONE - SIMULANTS

Course Code: 54B10 OBUT (ST)
POI File #: NN-03-HD
Hours: 4.4
Type Class: .5C./3.9PEi
Security Classification: UNCL

ADVANCE SHEET

Practical Exercise
Toxic Agent Training Exercise (Day 1)

I. Objective:

ACTION 1: Detect, Identify, and Decontaminate Chemical Agents.

CONDITIONS: Given M8/M9 paper, M256 kit (trainer), M58A1 kit, M11, M13 DAP, TAP apron, Chemical protective suit, mask, CAM, M8 Alarm, and a simulated toxic agent environment.

STANDARD: In Accordance With FM 3-5, STP 3-54B1-SM, STP21-1-SMCT.

II. Tasks:

031-503-1015	Put On and Wear MOPP Gear
031-503-1002	Put On, Wear and Remove Your M17-Series Protective Mask.
031-503-1020	Use M9 Detector Paper to Detect Chemical Agent.
031-503-1014	Use M8 Detector Paper to Identify Chemical Agent.
031-503-3001	Use the M256 or M256A1 Chemical Agent Detector Kit.
031-503-1007	Decontaminate Your Skin and Personal Equipment
031-503-1022	Decontaminate Equipment Using the M13 Decontaminating Apparatus, Portable.
031-503-2002	Decontaminate Equipment Using the ABC-M11 Decontaminating Apparatus.

III. Student Preparation: Apply knowledge acquired in Chem/Bio classes.

INITIAL ENTRY TRAINING
TASKS, CONDITIONS, STANDARDS
DAY TWO - LIVE AGENTS

Course Code: 54B10 OSUT (ST)
POI File #: NN-04-HD
Hours: 5.4
Type Class: .5C./4.9PE1
Security Classification: UNCL

ADVANCE SHEET

Practical Exercise
Toxic Agent Training Exercise (Day 2)

I. Objective:

ACTION 1: Detect, Identify, and Decontaminate Chemical Agents.

CONDITIONS: Given M8/M9 paper, M256/M256A1 Chemical Detector Kit, M256A1 kit, M11, M13 DAP, TAP apron, BDO, mask, CAM, M8 Alarm, and an actual toxic agent environment.

STANDARD: In Accordance With FM 3-5, STP 3-54B1-SM, STP21-1-SMCT.

II. Tasks:

031-503-1015	Put On and Wear MOPP Gear
031-503-1002	Put On, Wear and Remove Your M17-Series Protective Mask.
031-503-1020	Use M9 Detector Paper to Detect Chemical Agent.
031-503-1014	Use M8 Detector Paper to Identify Chemical Agent.
031-503-3001	Use the M256 or M256A1 Chemical Agent Detector Kit.
031-503-1007	Decontaminate Your Skin and Personal Equipment
031-503-1022	Decontaminate Equipment Using the M13 Decontaminating Apparatus, Portable.
031-503-2002	Decontaminate Equipment Using the ABC-M11 Decontaminating Apparatus.

III. Student Preparation: Apply knowledge acquired in Chem/Bio classes.

APPENDIX B

Walter Reed Army Institute of Research Study entitled "Stress, Confidence, Performance, and Credibility Produced by Toxic Agent Training at the Chemical Decontamination Training Facility" (1989)

STRESS, CONFIDENCE, PERFORMANCE, AND CREDIBILITY PRODUCED BY TOXIC AGENT TRAINING AT THE CHEMICAL DECONTAMINATION TRAINING FACILITY

Final Report for the
U.S. Army Chemical School

by

COL C. Fred Tyner, MC
LTC Frederick J. Manning, MS
LTC Marvin A. Oleshansky, MC

Walter Reed Army Institute of Research
Washington, D.C. 20307-5100

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SUMMARY

This evaluation measured the stress associated with a training exercise involving chemical warfare agents and tested whether the exercise changed the confidence, credibility or performance of those taking it. The on-site evaluation included over 100 subjects for all tests and over 1000 for some. An additional part of the study addressing credibility was conducted away from the training site during the same approximate time and involved 240 non-Chemical Corps subjects. Biomedical, questionnaire, and behavioral measures of stress were not in strong agreement, but on the whole supported the conclusion that the training exercise was mildly stressful. Questionnaire measures of confidence related to working on a chemically contaminated battlefield were clearly higher for subjects trained with toxic agent than for subjects without such training. Combat Arms Officers and NCOs were strongly in favor of such training for their own units as well as the Chemical Corps, suggesting that the exercise will enhance the credibility of graduates.

INTRODUCTION

This report describes an evaluation of certain aspects of the new Chemical Decontamination Training Facility (CDTF) at the USA Chemical School, Ft. McClellan, Alabama. The CDTF includes a specially designed indoor environment where military vehicles are contaminated with small amounts of potentially toxic agents. Trainees perform detection and decontamination exercises on these vehicles while wearing a standard issue (MOPP IV) protective ensemble. The questions to be answered concern the value of the toxic agent exercise and the stress and perceptions associated with it. This evaluation was carried out in response to a request by the Undersecretary of the Army, through the Army's Training and Doctrine Command (TRADOC), to the Office of the Surgeon General (OTSG).

The School provides instruction to Chemical Corps personnel ranging from junior enlisted through mid-career officers. In a series of courses including both classroom and practical exercises, students learn to detect chemical warfare agents, decontaminate personnel and equipment, recognize and treat symptoms of toxic agent poisoning, assess chemical battlefield scenarios and do a variety of other related tasks. In the belief that realism enhances training effectiveness, each course ends with an exercise using actual toxic agents in the CDTF. Beginning in mid-March 1987, the chemical instruction block of each course has ended with the CDTF program.

The CDTF exercise, as originally implemented, occupied two successive mornings, each starting with a detailed safety briefing. On the first day, students rehearse agent detection and vehicle decontamination in MOPP IV in the open air; no agent is used. On the second day, students work inside and encounter several military vehicles contaminated with approximately 5-9 cc of either concentrated VX or GB. They attempt to identify the agent on each vehicle and perform the appropriate decontamination routine. Students know in advance neither the identity nor the amount of agents. VX is non-volatile and a threat by skin contact. GB is volatile and a threat through inhalation, eye or skin contact. Five to nine cc of either agent would be quickly lethal if fully taken into the body and will activate the agent detectors with which the students are trained. The vapor hazard from five cc of GB in the exposure facility is estimated to produce mild eye symptoms after about two hours in an unprotected individual.

Planning for the CDTF included extensive discussions among the Chemical School and the Army Medical Department including the Health Service Command's Environmental Hygiene Agency and the Consultant to the Surgeon General for Preventive Medicine. Discussions concerned the kinds and amounts of agents to be used and the safeguards needed to protect both students and CDTF staff. These efforts determined the guidelines for a specially designed building with sophisticated ventilatory and other decontamination equipment, sensitive chemical agent monitoring devices, amount of agent in use at any time, procedures for entering and leaving rooms containing toxic agent, medical testing of trainees and staff, screening of trainees and other precautions.

GENERAL OBJECTIVES

Our objectives addressed two broad concerns generated by the use of toxic agent and by the facility's safety measures:

A. Are Chemical School programs substantially more stressful for including training with actual agent? This concern was prompted by the main argument offered in support of the CDTF that realistically demanding exercises will better prepare students to perform well in combat. But what if students don't take the facility and exercise

seriously? The amount of agent is small and the precautions numerous and obvious; perhaps it is all so safe as to not be particularly stressful. We examined this concern with a multi-dimensional assessment of stress associated with the CDTF exercise and the trainees' perception of it. The measures employed were sufficiently sensitive to allow detection of incremental changes in stress relative to the School's pre-CDTF programs and sufficiently established to allow comparison with other obviously stressful situations such as parachute jumping.

B. Regardless of how stressful the CDTF experience may be, are there changes in other measures more directly related to trainees' future success? This concern arose because the final goal of training is not to create stress per se, but to enhance the student's confidence that his training, equipment and doctrine will be an effective counter to the use of chemical agent weapons by some future enemy. An additional goal is to enhance the credibility of the graduates in the eyes of those they serve with and under after they leave the school. Implicit in these goals is the assumption that increased confidence and credibility will mean enhanced battlefield performance. We thus measured three additional parameters to which realistic training may be related: confidence, credibility and performance.

Stress is generally related to performance through an inverted U function: some stress is valuable, a bit more may be better, too much is detrimental. The means for studying confidence, credibility and performance are situation specific so that we were able to detect incremental changes between the new and current Chemical School programs, but we were unable to make simple comparisons with other environments outside the School or to place incremental changes on an absolute scale.

HYPOTHESES

A. Ft. McClellan courses including the CDTF will be more stressful than courses not employing toxic agent.

B. Soldiers trained in the CDTF will be more confident than those not so trained.

C. Soldiers trained in the CDTF will be more credible outside the Chemical Corps than those not so trained.

D. Soldiers trained in the CDTF will perform better than those not so trained.

STUDY PLAN

Special features and constraints

Several aspects of the situation under study particularly influenced the design of the evaluation.

1. The CDTF could begin operation only once. After toxic agent was first made and used there, the School could not advertise the facility as "clean". Crossover designs were thus excluded. Thus, the outcome may thus have been influenced by uncontrolled factors differentially affecting subjects in the two phases of the study (e.g. seasons of the year, recruiting standards and other variables that may have changed over time).

2. Trainees were told about the toxic agent exercise at the start of each Chemical School course. Knowing about the upcoming trip to the CDTF may have influenced the

students to pay better attention to course material and may be an important means of accomplishing this desired end. We could not blind the trainees, the trainers or the experimenters on the identity of reference and experimental subjects. Outcomes may have been influenced by the expectations of those involved.

3. We cannot state a precise start time or duration for "the event" being studied at either the individual or organizational level. Students may have anticipatory reactions before actually entering the contaminated rooms. As discussed below, we managed this issue by collecting some data before the subjects take the exercise itself. In addition, Ft. McClellan almost certainly experienced a collective "novelty" response associated with starting CDTF operations. Publicity, visitors, new procedures, personnel re-assignments, etc., all had effects. Because students go through the CDTF at a high rate (over 100/week) and because of our experience evaluating introduction of the Army's COHORT system, we think the novelty effect should have worn off in a month or two. We thus started much data collection well before first use of the CDTF and continued for several months afterwards

4. Studying the CDTF involved choosing a suitable reference to address the question of "how stressful compared to what?". Had the School simply added toxic agent to the ongoing exercises, without other significant changes, we could easily have studied those exercises before agent was introduced for reference. However, the CDTF "package" was an entirely new part of the curriculum which, besides toxic agent exercises, includes a forbidding new building, special medical screenings for students, safety briefings and elaborate emergency procedures. Thus, there was no simple baseline for comparison. We managed this issue in two ways. First, the biomedical stress measures employed have been studied in other, undeniably stressful situations such as parachute jumping, cardiovascular "stress" testing and appearance before a military awards board. We thus drew general comparisons between the CDTF experience and stressful situations outside the School. Second, the School conducted, at our request for the purpose of this evaluation, a CDTF "dry" run when the facility first became available. The "dry" run involved all CDTF facilities and procedures but no toxic agent. Participants knew that no agent was involved. This reference period, although artificial was unavoidable for isolating the specific question prompting this study: does toxic agent itself make a signifcant difference in training.

5. Because the School teaches many courses to a variety of students and some kinds of trainees pass through in much larger numbers than others, there was no single "program" to be evaluated, although the CDTF exercise itself is identical for everybody. We managed this issue by focusing attention on a distinction we and the School staff think may be critical: prior Army/Chemical Corps experience vs. no previous experience. Subjects were drawn only from Officer Basic, Officer Advanced, ANOC and AIT classes.

6. We cannot state for all hypotheses and tests the smallest size change to be declared meaningful. For example, we can argue confidently that a heart rate increase from a resting value of 65 to 75-80 beats per minute (about 1 standard deviation) is the least change consistent with "stress", but we can make no similar statement about confidence. If a 20% increase in confidence is important, should a 4% increase be judged trivial? We thus faced difficulty in choosing appropriate sample sizes for many individual tests. We attempted to manage this issue by erring on the side of too much data rather than too little for most measures.

7. The kinds of data needed to address all hypotheses could easily have generated a study which overwhelmed the School's ability to conduct business normally and distorted the phenomena we hoped to assess. We managed this issue by restricting some intrusive

data collection procedures to limited periods of time and modest samples of subjects. The data involved, fortunately, were those for which we had the clearest idea of minimal useful sample size.

8. We were severely limited in attempting to collect data, other than by simple observation, inside the CDTF during the toxic agent exercise itself. This was partly because decontamination regulations restricted our ability to make measurements (e.g. draw blood samples) and move measurement tools (clip-boards, blood pressure monitors, etc.) in and out of the training rooms. It was also because the number of students in each CDTF group (10-20), and the collective nature of the identification/decontamination exercise, precluded any easy assessment of individual task performance ability. We thus collected most data immediately before and after the actual exercise.

Study design. Because a major goal of the CDTF is to reduce the stress of a future chemical battlefield by showing soldiers they can survive and function in the presence of chemical warfare agents, we were interested in studying whether a successful decontamination exercise was associated with decreased stress on a subsequent exercise. To facilitate this, the Chemical School agreed to extend CDTF exercise to 3 days for the eight classes from which we collected our biomedical measures of stress.

Hypotheses A,B & D (stress, confidence and performance) were evaluated at the Chemical School through a one-time, unblinded comparison of measures taken before and after introduction of toxic agents to the CDTF. Major features of this procedure were a simple before-after contrast ("dry" run vs. "wet" run) with no crossovers. Data collection for performance measures and confidence started six months before the CDTF opened and continued for three months afterward. Hypothesis C (credibility) was studied away from the Chemical School with a short questionnaire at combat arms posts in the U.S. and Germany. The study plan will be elaborated by describing the dependent variables, subject selection, sample size, data collection, and data analysis.

Dependent variables. Stress was assessed through biomedical and psychological measures generally associated with "stress" responses. Biomedical measures included heart rate, blood pressure, blood hormones (cortisol, prolactin, ACTH and beta-endorphin) and overnight urinary hormones (cortisol and adrenalin). Heart rate, blood pressure and blood hormones are relatively acute indices of stress with rapid response times. Overnight urine collection (all urine from midnight until arrival at the CDTF at 0730) for stress hormones provides an integrative index reflecting a longer time period. These measures have well established population values and have been studied previously in clearly stressful situations - such as parachute jumping and appearance before military boards (1-4). With the exception of heart rate, these measures were collected before and after the CDTF exercise (see Fig. 1). Subjects were asked to refrain from heavy exercise on the test days to avoid contamination from intense exercise. Heart rate was collected with a 4-lead battery powered portable recording system (Medilog) worn under the uniform by a subset of subjects from 0630 until the conclusion of the CDTF exercise each day. Actual heart rate data used in the analyses was limited to minute by minute rates for the first 10 minutes in the "hot" section of the facility during protective mask testing and the first 10 minutes following application of toxic agent to the vehicle to be decontaminated. Physical activity during both of these periods is limited and relatively standardized.

Psychological stress measures included: a mood adjective checklist which can be analyzed to provide indices of fear, anger, depression, fatigue, activity and happiness. This checklist has previously proved sensitive in military exercises involving the chemical protective suit (Appendix 3, ref. 5). Group interviews of students and instructors

participating in the exercise, student estimates of the risk entailed by the CDTF exercise and direct observation of students during the exercise were also included. Interviews allowed us to pick up information not available through the standard tests. The risk scales, unlike the mood scales, provided the subjects a chance to report their perceptions of potential or experienced stress without labeling themselves or their own feelings..

Confidence was evaluated with a questionnaire written especially for this study (Appendix 1). It consisted of ten questions, to be answered on a seven point Likert scale, addressing the soldier's confidence in his ability and that of his classmates to survive a chemical attack, identify agent, decontaminate equipment, provide first-aid, and instruct others on how to do these things. It was given once, as part of the end-of-course critique following completion of the CDTF exercise. Pre-tests at the School showed responses to be distributed in two senses: first, they were not so extreme as to preclude improvement/decrement; second, they showed confidence to be greatest on those tasks most heavily emphasized in the instruction.

Credibility was evaluated with a specially designed questionnaire (Appendix 2) given to NCO's and officers in combat arms assignments. Four questions assessed the extent to which respondents believed toxic agent training would have positive effects on their unit. One question asked the subjects how much he would pay, in unit training time, to get such training for his own soldiers. This questionnaire also underwent considerable pretesting and revision to insure face validity with both subjects and Chemical School staff and a response distribution which would allow detection of a small improvement (or decrement) in credibility.

Performance was evaluated by examining the scores of written competence tests given by the School as part of its regular instruction process. Because all instruction and testing is done before the CDTF drill, consistent changes in test scores might be attributable to an anticipatory effect associated with the facility. Although written School tests are certainly an imperfect and limited index of battlefield performance capacity, safety regulations and the collective nature of the decontamination exercise precluded any measure of hands-on performance in the CDTF itself.

Subject selection. The Chemical School staff suggested evaluating officers and enlisted, experienced and naive subjects . They offered the opinion that the most important distinction may fall between experienced and inexperienced, that is, between officers and enlisted soldiers new to the Army and Chemical Corps and those with several years' previous Chemical Corps experience. We accordingly drew subjects from four School courses: Officer Basic (OB), Officer Advanced (OA), Junior Enlisted (B10), and Advanced Non-Commissioned Officer (ANOC).

Sample size. Performance and confidence measures were collected from all students at the school for six months preceeding and for three months following introduction of toxic agent into the CDTF. All other measures were collected from volunteers solicited several days prior to the CDTF exercise, after a thirty minute group briefing on the nature of the study. Students were encouraged to volunteer to provide all dependent measures but were allowed to particpate in any subset of their choosing. Classes for the four courses included 20-40 students each. Volunteer rates were generally lowest for providing blood samples (12-20 from a class of 20-40). Mood questionnaires and blood pressure measurements were offered by nearly all students (>90%). Overnight urine samples were provided by >80% in every class. More than 50% of each class volunteered to wear cardiac monitors. As we had only fifteen monitors available, volunteers were selected for cardiac monitoring first from those who had volunteered for all dependent variables. If more than fifteen individuals volunteered for all variables, we simply chose

fifteen subjects at random. Volunteers received no rewards for participating and non-volunteers were in no way discriminated against. These conditions were made known before soliciting participation.

The sample for the credibility questionnaire consisted of 190 NCOs and 48 company grade officers from combat arms units at two bases in the U.S. and two in Germany. No attempt was made to collect a sample representative of the entire Army. The bases sampled were, by and large, those at which we are conducting other studies. Branches included in significant numbers were infantry, armor, engineers, aviation.

Statistical Analysis

The biomedical data was subjected to repeated measures analyses of variance (ANOVA) using the General Linear Model (GLM) procedure of SAS Institutes Statistical analysis System. A conservative significance level of 0.01 was chosen because of the large number of dependent variables (and tests) involved.

RESULTS

Stress

Urinary hormones. Table 2 displays the data on overnight urinary output of the "stress" hormones, cortisol, adrenalin, and noradrenalin, grouped according to type of course (basic, i.e., AIT and Officer Basic; and advanced, i.e., Officer Advanced and Advanced NCO). As summarized on the bottom row of Table 2, cortisol output did not vary over the three days of the exercise in either the "dry" control exercises or the "wet" toxic agent training exercises and was not different between dry or wet runs in either basic or advanced students. Adrenalin output, on the other hand, was statistically increased during the toxic agent training exercises compared to the control period (Figure 1). The significant agent by experience interaction reflects the fact that the difference in dry run and wet run adrenalin output was almost entirely confined to the basic course groups (Figure 2). Adrenalin output was higher on each of the three nights before the wet run exercises compared to the dry runs, even though the first day of the wet run employed simulated agent and was run out of doors. Noradrenalin output was associated with a significant agent by experience interaction. This was the product of noradrenalin output being higher for the basic course and being lower for the advanced course during the wet runs as compared to the dry runs. Overall, these findings support the hypothesis that working with actual toxic agents during exercises at the CDTF would be more stressful than similar exercises during the control period and suggest that even anticipation of training with actual toxic agents is stressful.

Blood hormones. Blood samples collected just prior and just subsequent to the training exercises were designed to look at instantaneous stress hormone levels, at times closer to the exercise itself than the overnight urine collection allowed The best test of the hypothesis that toxic agent training was stressful would have been samples taken during the exercise itself but this procedure was precluded by subject safety considerations. Table 3 displays the data for plasma cortisol and several other stress hormones including adrenocorticotrophic hormone (ACTH), beta-endorphin and prolactin. These four hormones did not vary over the three morning (before) samples for the exercises in either the dry or the wet runs. None of the hormones appeared to be affected by the "threat" or "fear" of toxic agent training in either the basic or advanced classes. Values of cortisol and ACTH were lower after the exercise on Day 2 than prior to training on any of the three days, producing a significant time effect in the analysis for these hormones. Although this decrease might be attributed to a decrease in stress upon completion of a hazardous job, it is also the case that cortisol and presumably

ACTH show a pronounced durinal rhythm, a rhythm which is associated with steadily decreasing values throughout the day. The time x agent interactions reflects the finding that wet exercises were associated with a smaller decrease over the same time period than the dry exercises. We can speculate that this means that the wet runs were more stressful than the dry runs.

Blood pressures. Blood pressure, like blood hormones, were also sampled just prior to and subsequent to each 2-4 hr training session. Table 4 shows our findings. Although all values for both systolic and diastolic pressure are tightly clustered, ANOVA revealed significantly higher systolic and diastolic blood pressures for the advanced classes. This can be most parsimoniously explained by their higher age. There were significant agent and time effects for diastolic blood pressure as well. The time effect reflects a very small (3mm) but consistent decrease over the four measurements, which is consistent with a decreasing level of stress. The finding that diastolic blood pressures were higher in the dry runs, however is the reverse of that predicted by hypothesis A. The only legitimate conclusion from these data is that there is probably some stress involved in the CDTF, but that blood pressure measures provide no evidence for the hypothesis that it is primarily due to the toxic agent training.

Heart rate. A similar conclusion can be drawn from data on heart rate (Table 5). Pulse rates were taken in conjunction with the blood pressure measurements prior to entering the CDTF training building. Additionally, heart rate was recorded in a sample of fifteen subjects throughout the exercise proper. The center and right columns of the tables show selected data collected during the time in the mask check room and for ten minutes upon first entering the training bays. These time periods were selected not only because stress was presumed to be highest during the mask check and upon initial entry into the training bays. Subjects were, by and large, standing quietly listening to instructions so that changes in heart rate can reasonably be attributed to anxiety rather than physical work. Both the heart rate from the highest single minute from the first ten min in the mask check room or the training bays or the mean heart for these periods were markedly elevated over classroom values. Statistical analysis provided no justification for attributing this increase in heart rate to toxic agent training, since the elevated rate was just as prominent in the dry run as the wet run. This finding suggests that wearing MOPP gear, going through the mask check, or some perception associated with the entering the training facility provoked autonomic arousal. In general, pulse rates were inexplicably lower for the wet runs compared to the dry runs. Overall, these findings for heart rate suggest that training at the CDTF is stressful but they do not provide support for hypothesis A, that training with toxic agents will be more stressful compared to training with simulants.

Taken as a whole, the biomedical measures of stress (hormones, blood pressure, heart rate) provide only modest support for hypothesis A, that courses including toxic agent training in the CDTF are more stressful than courses not employing toxic agent. The data provide somewhat more support for concluding that training in the CDTF, with or without agent, is a significant stressor.

Questionnaires. The biomedical measures of stress were supplemented by questionnaire measures administered immediately prior to and subsequent to each day's training exercise. Subjects were instructed to answer the second questionnaire each day by describing their mood during their initial moments in the exercise itself. Table 6 summarizes the data of interest from the mood checklist. The "fear" columns show the mean scores on six near-synonyms of fearful, where zero means "not applicable to me at the moment" and six means "very much true of me at the moment". The "fatigue" colums also shows mean scores for six near-synonyms of tired. The right half of the

table shows the highest scores on twelve adjectives generally associated with "positive" mood (e.g. happy, lively, satisfied) and twenty-five adjectives indicating "negative" mood (e.g. downcast, angry, uneasy, miserable). The data in the table were analyzed with a repeated measures ANOVA and the bottom row of the table summarizes the findings. Fear scores were very low overall, especially for the ANOC and OA subjects. Fear scores for the basic group appeared to be nearly as high in the dry run as the wet run with the exception of just prior to entering the training bay (pre-day 2, Figure 3). This was not the case for advanced subjects who appeared to have higher scores throughout the wet run compared to the dry run. Both the basic and advanced groups had a significant falloff in fear scores after day 2. Fatigue scores were notable only in reliably declining over the three days, as did positive mood scores. The wet groups, regardless of course type, generally scored higher on positive adjectives.

Table 7 shows the mean subjective risk associated with the CDTF exercise, parachute jumping and the ratio of assessed risk of CDTF exercises and parachute jumping. A zero score represents "a completely no-risk activity" and a score of ten "the most risky or dangerous activity a person could possibly do". Students in the wet runs did not differ from subjects in the dry runs in their assessment of the risk of parachuting. These ratings stayed steady at about 6.0 throughout the three days. Students in the wet runs assigned the CDTF exercises a rating of about 4.5 on this scale prior to training, while subjects before the dry runs rated the CDTF at about 2.5. After three days of training at the facility, these ratings dropped to about 2.5 and 1.6, respectively. Students in both dry and wet runs saw the CDTF training as considerably less dangerous after the training (Figure 4). There was no evidence of differences in any ratings between the basic and advanced groups.

Direct observation. Analysis of observer notes on student-initiated departures from the training exercise revealed a striking difference between the dry run classes and their counterparts working with toxic agents. Table 8 shows the incidence of these departures and the reasons provided by the students. Our observers' notes were supplemented by analysis of CDTF records which routinely recorded such incidents. The data in the table includes all classes going through the CDTF between January and May 1987. Students came out of the exercise more than six times more frequently when toxic agent was employed, strongly suggesting that training with toxic agent is more stressful than CDTF training with simulants. It should be noted that none of these students showed any clinical indication of exposure to agent or a drop in red blood cell cholinesterase which would follow such exposure. Most of the students returned to the exercise within minutes, though in a number of instances these minutes included a reminder that graduation was contingent upon successful completion of CDTF training.

In summary, the biomedical, subjective, and behavioral measures of stress described above provide modest support for hypothesis A, that CDTF training with toxic agents is more stressful than such training not employing toxic agent. The single most well-accepted hormonal measures of stress, adrenalin, was significantly higher in the classes using toxic agents, especially the junior enlisted and officer basic classes. Although few soldiers admitted to feeling much fear about the exercise, the junior enlisted and officer basic students in the wet runs initially rated the training nearly as dangerous as parachuting. Soldiers found reasons to leave the training exercise six times more frequently when toxic agents were involved than when detection and decontamination involved simulants.

Confidence. Comparisons of control and agent classes on each of the ten questions of the confidence questionnaire are shown in Table 9 and Figure 5. Scoring was reversed on question #3 for ease of display and analysis. This question, which asks students how many

of their classmates will panic the first time they face a major chemical attack, would be given a low rating by confident soldiers, unlike the remainder of the questions, where confidence would be indicated by high scores. The data in the table were again analyzed with a repeated measures ANOVA, with agent (wet, dry) and experience (basic, advanced) as between-subjects variables. Training with toxic agents had a highly significant effect. In fact, subjects in the wet runs scored significantly higher than controls on every one of the ten questions. Experience was also a significant factor. Basic course students generally expressed more confidence than advanced course students with statistically significant differences on questions 2,5,8,9, and 10. The significant F-ratios for Questions and interactions of agent and course type with Question merely confirms that the ten questions were not completely redundant - i.e. scores of all four groups varied across questions. Hypothesis B, that soldiers trained in the CDTF with toxic agent will be more confident than those not so trained, seems solidly confirmed by these data. This was true for both basic and advanced courses.

Credibility The seven-item credibility questionnaire (Appendix 2) was analyzed in three parts: questions 1-4, which generally ask the respondent to indicate the extent to which he believes the use of toxic agent in the training of Chemical Corps NCO's and officers will have a positive effect on his unit and ones like it; question 5, which asks the respondent how much he would pay, in training time, to obtain live agent training for his soldiers; and questions 6-7, which assess the respondent's view of his unit's current readiness to fight on a chemical battlefield. The last two questions were included not so much as credibility measures, but as an aid in interpreting the data from questions 1-5. It would be reasonable to expect that officers or NCO's who were currently very confident in their units' ability to perform despite attack by chemical weapons would be unwilling to spend additional training time for toxic-agent training for their soldiers. For security reasons, we do not report the mean scores on these two questions, but there were no significant correlations between scores on these questions and scores on questions 1-5. Judgments about the desirability of toxic agent training were made independently of judgments about the readiness of one's own unit.

Table 10 shows the mean scores on each of the first five questions. Analysis of variance showed nc significant effects of rank (NCO vs Officer), location (4 bases), or specialty (11 different fields), so the scores shown include all respondents. Mean scores are uniformly high and the modal score (i.e. the single most commonly chosen answer) was 6 for every question, expressing maximum approval of toxic agent training. For each of the 5 questions, over 30% of the respondents gave this answer. Figures 5 and 6 show the breakdown of responses by per-cent to Question 1-4 and Question 5, respectively,

Performance Scores on the final exam for the chemical block of all four student course groups contributing subjects to this study were the sole measure of performance employed. Even though in most cases this exam took place prior to the CDTF training exercise, it was hypothesized that anticipation of toxic agent training would have a positive effect on student motivation, which would be reflected in higher grades on the final exam. As Table 11 reveals, the data failed to support this hypothesis. Exam scores in general were quite high, averaging about 90%. This suggests that students were highly motivated, with or without toxic agent training in their future. The small but statistically significant difference between the test scores for the basic and advanced course students suggests that there was perhaps still room for improvement with the introduction of toxic agent training. Confining the analysis to those who scored less than 70, or less than 80, or less than 90, did not alter the conclusion that the prospect of toxic agent training had no effect on final exam scores. For example, just as many students scored below 70 in the agent classes as in the control classes.

DISCUSSION

To study the impact of training with toxic agents at the new Chemical Decontamination Training Facility, we addressed two broad concerns: 1) Are Chemical School programs substantially more stressful for including training with actual agent? and 2) Regardless of how stressful the CDTF experience may be, are there changes in other measures more directly related to trainees' future success?. The four hypotheses to be tested necessitated a comprehensive battery of objective and subjective measures to permit generalizations from the findings. We envisioned three possible outcomes: 1) changes in the direction of "more" stress, confidence, credibility and improved performance; 2) changes in the direction of "less" stress, confidence, credibility and decreased performance; and 3) no change. More stress was presumed to be desirable, within limits described below. Less stress would be viewed as undesirable, as the goal of the program is to provide more stressful and therefore more realistic training. No change is generally not interpretable, as it could mean either no effect, an inappropriate measurement or a poorly done measurement. This is a particular concern because we were studying a new environment with few "textbook" values. Thus, in thinking about the overall outcome, we tend to ignore the "no difference" outcomes and contrast the "more" with the "less" outcomes.

To study these issues, we employed an open comparison of training in the new facility with simulants or toxic agents. Classes from each of the four major student groups, namely AIT, ANOC, OB and OA, voluntarily participated in the two phases of the study. Approximately 125 soldiers volunteered in both the dry runs and wet runs which represented over 90% of those going through the training during the study periods. Nearly all volunteers filled out questionnaires and collected three consecutive overnight urine samples. Approximately half had repeated venipuncture for blood collection. Additionally, nearly 1000 performance measures and confidence questionnaires were collected for six months before the CDTF opened and for three months afterward. The credibility questionnaire was admininstered to 240 Combat Arms Officers and NCO's at combat arms posts in the U.S. and Germany.

Biomedical, questionnaire and behavioral measures of stress were not in strong agreement, but provided modest support for hypothesis A, that CDTF training with toxic agent is more stressful than similar training not employing agent. The single most well-accepted hormonal measure of stress, urinary adrenalin, was significantly higher in the the junior enlisted and officer basic classes during the "wet runs" after toxic agents were added to the training than in the "dry runs". Adrenalin output was higher on each of the three nights before the wet run exercises, even though the first day of the wet run employed simulated agent and was run out of doors. This suggests that mere anticipation of training at the CDTF with toxic agents is stressful and that the stress of toxic agent training is not limited to the exercises in the training bays. Although few soldiers admitted to feeling much fear about the exercise, junior enlisted and officer basic students anticipated that the CDTF exercise with toxic agents would be nearly as dangerous as parachuting. This perception declined after actual participation in the training. Soldiers found reasons to leave the training bays six times more frequently when toxic agent was involved than when detection and decontamination were simulated.

The failure to detect changes in plasma hormones may reflect the immediate and short-term nature of the actual exercise in the training bays when we were unable to collect samples due to safety reason. Conversely, the major stressor may not have been sufficient to stimulate increased secretion of the hormones measured. This would appear to be the case as cortisol has a delayed response and a sufficiently long half-life in plasma to be useful as a marker of stress in the period following the actual incident.

Thus, while the anticipation and perception of the danger of toxic agent were sufficient to cause arousal and avoidance responses in the subjects, the stress was clearly not of the magnitude associated with parachute jumping. This is not surprising as biomedical responses are most likely to be large when an individual perceives something as "instinctively" threatening or dangerous, such as being attacked by a large animal, falling from a height, being trapped in a fire, etc. Biomedical responses are less likely to be robust when facing something known to be dangerous only because someone told you so and, as in this case, when extensive safeguards are provided.

How stressful, then, was the toxic agent training exercise? It was clearly not so unremarkable that it failed to impress anything useful on those going through it, but it was not so threatening or terrifying as to overwhelm the students and prevent them from learning from the experience. That is, the exercise is stressful enough to capture the student's attention, but not so stressful as to destroy training value. This appeared to be less true for the experienced soldiers and suggests that the program may need to be tailored to challenge the experienced soldiers.

Hypothesis B, that soldiers trained in the CDTF with toxic agent will be more confident of working on a chemically contaminated battlefield that those not so trained seems solidly confirmed by the consistently higher scores on the confidence questionnaires for subjects trained with toxic agent than for subjects without such training. It should be noted that the confidence levels of the students was quite high to begin with and suggests that the core curriculum is providing thorough training in the basics of chemical decontamination.

Assessing credibility generated by the CDTF among those outside the Chemical Corps was probably the most difficult hypothesis to test as it could only be approached indirectly. We couldn't follow the graduates of the CDTF for several years out in the field and compare them to those without such training. We had to settle on hypothetical questions which were poorly able to describe the CDTF enviroment in detail for those answering the questions. However, the enthusiasm for training with toxic agent shown by the Combat Arms Officers and NCOs who took the credibility questionnaire solidly confirmed Hypothesis C, that soldiers trained in the CDTF will be more credible outside the Chemical Corps than those not trained. Combat arms officers and NCO's were, in fact, strongly in favor of toxic agent training for their own units, as well as for the Chemical Corps.

Although a positive relationship with final exam scores would have further increased our own confidence in the ability of toxic agent training to enhance battlefield performance, final exam scores failed to provide any support for hypothesis D, that soldiers trained with toxic agent will perform better than those not so trained. Class scores were quite high in both situations and there would have had to be a huge impact to see such an effect. Failure to improve final exam scores should certainly not be taken as evidence that battlefield performance will be unchanged by toxic agent training.

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TABLE 1: Data Collection Plan.

GROUP:	BACKGROUND A	DRY RUN	BACKGROUND B	WET RUN
COMPOSITION:	300 E10; 60 ea OB, ANOC; 40 OA	25 ea. E10, OB, ANOC, OA	300 E10; 60 ea. OB, ANOC; 40 OA	25 ea. B10, OB, ANOC, OA
START:	12 weeks before CDTF opens	At CDTF opening	Immediately after Dry Run group	Immediately after Background B group
DURATION:	12 weeks	5 weeks	12 weeks	5 weeks
TOXIC AGENT:	Absent	Absent	Present	Present
BIOMEDICAL:	Not collected	All subjects, see in Figure 1	Not collected	All subjects, see Figure 1
MOOD:	Not collected	All subjects, see Figure 1	Not collected	All subjects, see Figure 1
RISK ESTIMATE:	Not collected	All subjects, see Figure 1	Not collected	All subjects, see Figure 1
INTERVIEWS:	4 classes	4 classes	4 classes	4 classes
CONFIDENCE:	All subjects	All subjects	All subjects	All subjects
PERFORMANCE:	All subjects	All subjects	All subjects	All subjects

TABLE 2: **Mean Urinary Concentrations (Mcg/8hrs) of Stress Hormones in Subjects Trained with Simulants (Dry Run; N=124) and Toxic Agents (Wet Run; N=101), Grouped by Type of Course (Basic or Advanced).**

	HORMONE					
	Cortisol		Adrenalin		Noradrenalin	
	Dry	Wet	Dry	Wet	Dry	Wet
Day 1						
Basic	15.6	19.1	1.7	3.6	6.7	7.9
Advanced	15.7	16.1	2.9	3.0	9.2	6.7
Day2						
Basic	18.8	14.7	1.9	3.1	7.3	7.0
Advanced	16.1	14.6	2.7	2.8	9.3	6.6
Day 3						
Basic	17.7	15.8	1.7	3.1	5.7	7.0
Advanced	13.6	16.7	2.6	2.7	8.6	6.1
Significant F ($p < 0.01$)	—		agent		—	
	—		agent x experience		agent x experience	

TABLE 3: **Mean Blood Plasma Concentrations of Stress Hormones in Subjects Trained with Simulants (Dry Run; N=120) and Toxic Agents (Wet Run; N=76), Grouped by Type of Course (Basic or Advanced).**

	HORMONE							
	Cortisol (mcg/dl)		ACTH (pg/ml)		Beta-Endorphin (pg/ml)		Prolactin (ng/ml)	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Day 1 (before)								
Basic	11.3	10.1	12.9	12.4	10.9	12.4	3.5	4.3
Advanced	13.2	11.1	16.8	11.0	11.8	11.7	4.5	3.5
Day 2 (before)								
Basic	11.4	10.6	13.3	12.4	12.5	11.3	4.8	4.6
Advanced	11.9	11.5	16.4	10.2	12.1	12.2	4.9	4.3
Day 2 (after)								
Basic	8.0	8.4	12.2	12.9	11.3	11.5	4.7	4.8
Advanced	8.2	9.6	12.1	13.8	10.6	11.5	5.1	4.5
Day 3 (before)								
Basic	10.6	9.8	11.7	10.6	10.8	11.5	5.1	5.0
Advanced	11.2	10.6	13.9	9.7	10.6	11.9	5.3	4.4
Significant F ($p < 0.01$)	time time x agent		time time x agent		--- ---		--- ---	

TABLE 4: **Mean Blood Pressures (Mm Hg) of Subjects Trained with Simulants (Dry Run) and Toxic Agent (Wet Run), Immediately Prior or Subsequent to CDTF Training, Grouped by Type of Course (Basic or Advanced).**

	Systolic		Diastolic	
	Dry	Wet	Dry	Wet
Day 1 (before)				
Basic	126	127	73	71
Advanced	128	129	83	79
Day 1 (after)				
Basic	122	123	73	72
Advanced	126	129	83	80
Day 2 (before)				
Basic	124	125	74	71
Advanced	126	128	80	78
Day 2 (after)				
Basic	124	123	73	70
Advanced	128	128	82	78
Day 3 (before)				
Basic	123	120	72	69
Advanced	127	126	82	76
Day 3 (after)				
Basic	124	121	72	68
Advanced	126	124	78	75
Significant F ($p < 0.01$)	----		agent	
	experience		experience	
	----		time	

TABLE 5: **Mean Heart Rates (bpm) of Subjects Trained with Simulants (Dry Run) and Toxic Agent (Wet Run), During Selected Periods of CDTF Training, Grouped by Type of Course (Basic or Advanced).**

	One Minute Seated in Classroom Just Prior to March to Training Building		Highest Single Minute While in Mask Check Room or First 10' in		Mean of First 10' in Mask Check and First 10' in Training Bay Training Bay	
	Dry	Wet	Dry	Wet	Dry	Wet
Day 2						
Advanced	67	63	94	96	84	84
Basic	67	66	99	94	88	82
Day 3						
Advanced	69	62	101	95	89	83
Basic	70	68	95	93	85	82
Significant F ($p < 0.01$)	—		Agent		—	

TABLE 6: **Average Scale Scores for Selected Elements of the Mood Adjective Checklist for Subjects Trained with Simulants (Dry Run) and Toxic Agent (Wet Run) Immediately Prior to and Immediately After Entering the CDTF, Grouped by Type of Course (Basic or Advanced).**

	Fear		Fatigue		Positive		Negative	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Day 1 (before)								
Basic	0.9	1.0	1.4	1.2	3.5	4.1	2.0	2.0
Advanced	0.4	0.7	1.1	1.1	3.7	3.8	1.7	1.6
Day 2 (before)								
Basic	0.5	0.9	1.0	1.2	3.6	3.9	1.8	1.9
Advanced	0.3	0.6	0.9	0.9	3.1	3.8	1.4	1.5
Day 2 (during)								
Basic	1.2	1.2	1.2	0.9	3.0	3.6	1.7	1.6
Advanced	0.4	0.9	0.7	0.9	3.0	3.5	1.1	1.4
Day 3 (before)								
Basic	0.4	0.4	1.0	0.8	3.6	4.3	1.6	1.2
Advanced	0.2	0.3	0.7	08	3.6	3.7	1.1	1.0
Day 3 (during)								
Basic	0.6	0.4	1.1	0.6	3.2	4.1	1.5	0.9
Advanced	0.3	0.4	0.6	0.5	3.4	3.8	0.9	0.7
Significant F ($p<0.01$)	time experience — agent x time		time — — —		time — agent —		time experience — —	

TABLE 7: **Mean Subjective Risks Associated with the CDTF Exercise and with Parachuting by Subjects Trained with Simulants (Dry Run) and Toxic Agent (Wet Run), Grouped by Type of Course (Basic or Advanced). (0= no risk; 10= "the most risky or dangerous activity a person could possibly do").**

	CDTF		Parachuting		CDTF/Parachuting	
	Dry	Wet	Dry	Wet	Dry	Wet
Day 1 (before)						
Basic	2.7	4.8	6.1	5.7	0.6	0.9
Advanced	2.3	4.0	6.5	6.2	0.4	0.7
Day 2 (after)						
Basic	1.9	3.1	6.1	5.3	0.4	0.7
Advanced	1.8	3.2	6.3	6.2	0.3	0.6
Day 3 (after)						
Basic	1.7	2.3	6.1	5.2	0.4	0.5
Advanced	1.6	2.8	6.3	6.1	0.3	0.5
Significant F ($p < 0.01$)	agent		———		agent	
	time		———		time	
	time x agent		———		———	

TABLE 8: **Frequency of Incidents Involving Student-initiated Departure from the CDTF by Subjects Trained with Simulants (Dry Run) and Toxic Agent (Wet Run).**

DRY RUN (SIMULANTS)

3 incidents/260 student days	= 1 per 87 student days	
Mask fit	2	
Vomiting	1	
Classes included:	1 each AIT, ANOC, OB, OA	

WET RUN (TOXIC AGENT)

58 incidents/798 student days	= 1 per 14 student days	
Mask fit	37	(64%)
Difficult breathing, dizziness, headache, nausea, too hot, etc.	11	(19%)
Torn glove, with or without cut skin	7	(12%)
Panic, refusal to enter	1	(2%)
Back pain	1	(2%)
"Smell agent"	1	(2%)

Classes included: senior command (2), OA (2), OB (2), ANOC (2), BNOC (4), AIT (4), EOD (1)

TABLE 9: **Ratings of Confidence in Various Aspects of Chemical Warfare Doctrine, Training, and Equipment by Subjects Trained with Simulants (Dry Run) and Toxic Agent (Wet Run), Grouped by Type of Course.**

Question		Advanced Courses		Basic Courses	
		WET (N=131)	DRY (N=206)	WET (N=202)	DRY (N=483)
1.	Protective clothing	5.14	4.19	5.19	4.23
2.	Own Training	4.65	3.61	4.97	4.35
3.	Classmates resistance to panic	3.69	2.73	3.23	2.67
4.	Own combat performance	4.49	3.72 (20.7%)	4.50	4.01
5.	Classmates combat performance	4.02	3.28 (22.6%)	4.12	3.67
6.	Value of agent training	5.43	4.67 (16.3)	5.31	4.48
7.	Classmates future teaching	4.50	4.09	4.68	4.26
8.	Classmates first-aid for chem casualty	4.21	3.40	4.34	3.99
9.	Classmates detect & identify agents	4.95	4.07	5.22	4.53
10.	Classmates decontaminate equipment	4.78	3.87	5.05	4.76

Significant ($p < 0.01$) F-ratio: Agent, Course Type, Questions

TABLE 10: **Mean Scores of Company-Level Officers and NCOs on Individual Items of the Credibility Questionnaire**

Questions		Mean	Mode	Range of Possible Answer
1.	Toxic agent training would help NCO's train your soldiers?	4.17	6	0 = no difference 6 = major improvement
2.	Toxic agent training of Chem Corps would improve your unit's survival of chemical weapons attack?	4.09	6	0 = no difference 6 = major improvement
3.	Toxic agent training of Chem Corps would enhance your unit's overall combat effectiveness?	4.07	6	0 = no difference 6 = major improvement
4.	Toxic agent training of Chem Corps would increase confidence of your soldiers? 71%	4.26	6	0 = no difference 6 = major improvement
5.	How much unit training time would you give up for toxic agent training for your soldiers?	4.01	6	0 = none 6 = 2 weeks/yr

TABLE 11: **Mean Final Exam Scores on the Chemical Phases of Chemical School Courses by Subjects Trained with Simulants (Dry Run) and Toxic Agent (Wet Run), Grouped by Type of Course.**

Basic Courses		Advanced Courses	
Agent (N=155)	Control (N=455)	Agent (N=111)	Control (N=205)
91.9	91.5	88.2	88.0

FIGURE LEGENDS

1. Timeline of biomedical and questionnaire stress measures in chemical decontamination training exercises.

2. Effects of chemical decontamination training exercises employing simulants (DRY RUN; n=120) or toxic agents (WET RUN; n=100) on overnight urinary epinephrine and norepinephrine excretion.

3. Effects of chemical decontamination training exercises employing simulants (DRY RUN; n=120) or toxic agents (WET RUN; n=100) on overnight urinary epinephrine excretion in the Chemical School's NCO and officer advanced course (ADVANCED; n=90), and enlisted and officer basic course (BASIC; n=130).

4. Effects of chemical decontamination training exercises employing simulants (DRY RUN; n=103) or toxic agents (WET RUN; n=109) on fear adjective checklist in the Chemical School's NCO and officer advanced course (ADVANCED; n=88), and enlisted and officer basic course (BASIC; n=120).

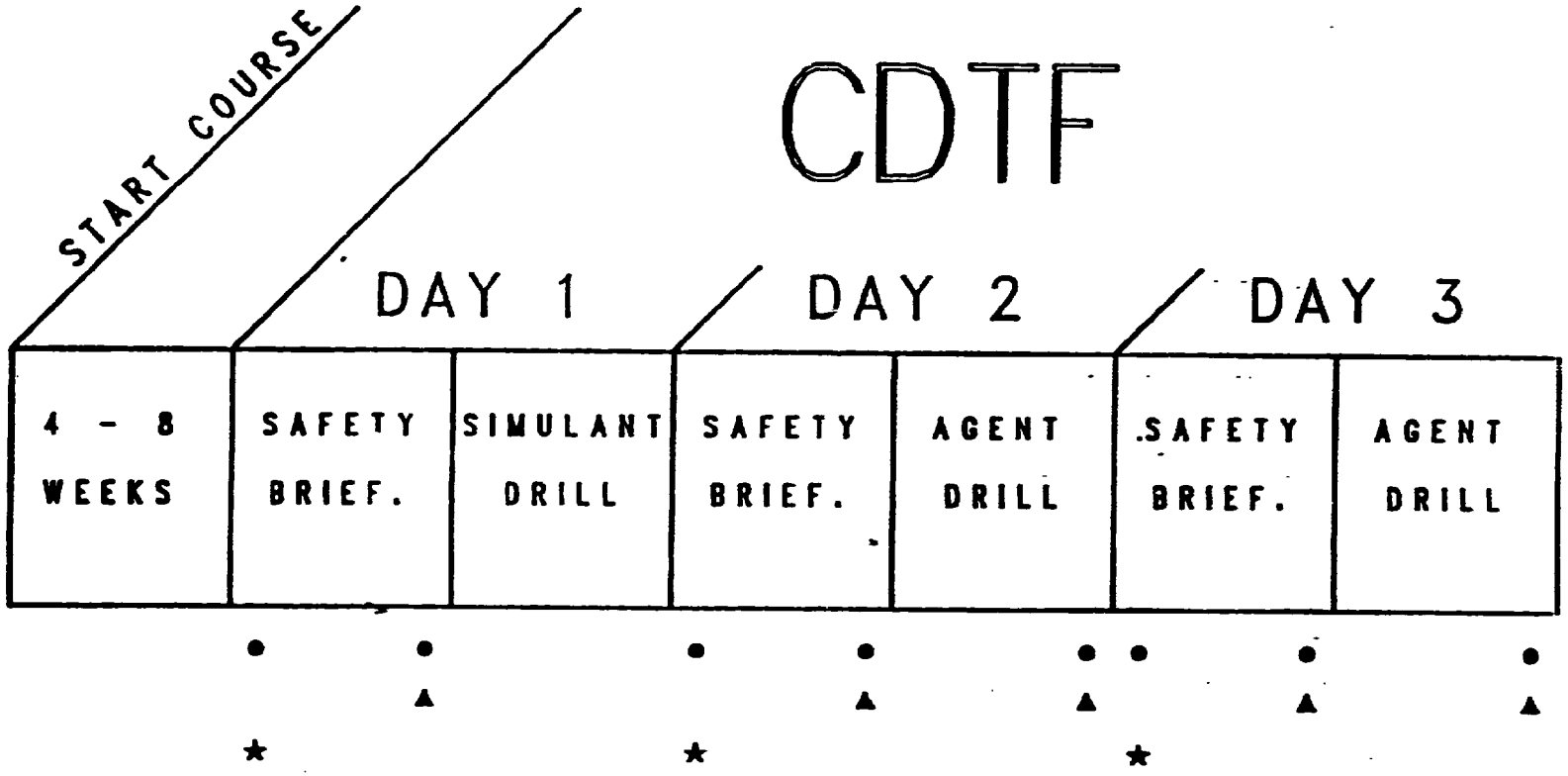
5. Effects of chemical decontamination training exercises employing simulants (DRY RUN; n=103) or toxic agents (WET RUN; n=105) on risk assessment scale expressed as ratio of perceived risk of CDTF exercise to perceived risk of parachute jumping in the Chemical School's NCO and officer advanced course (ADVANCED; n=88), and enlisted and officer basic course (BASIC; n=120).

6. Ratings of confidence in various aspects of chemical warfare doctrine, training and equipment by chemical school students in courses conducted prior to (CONTROL; n=689) and after (AGENT; n=333) introduction of CDTF toxic agent exercises (see Table 9).

7. Effects of chemical decontamination training exercises on credibility questions 1-4 (Table 10; n=240) expressed as the mean percentage responding at each point along a 6 point scale.

8. Effects of chemical decontamination training exercises on credibility question # 5 (Table 10; n=240) expressed as percentage responding at each point along a 6 point scale.

Figure 1

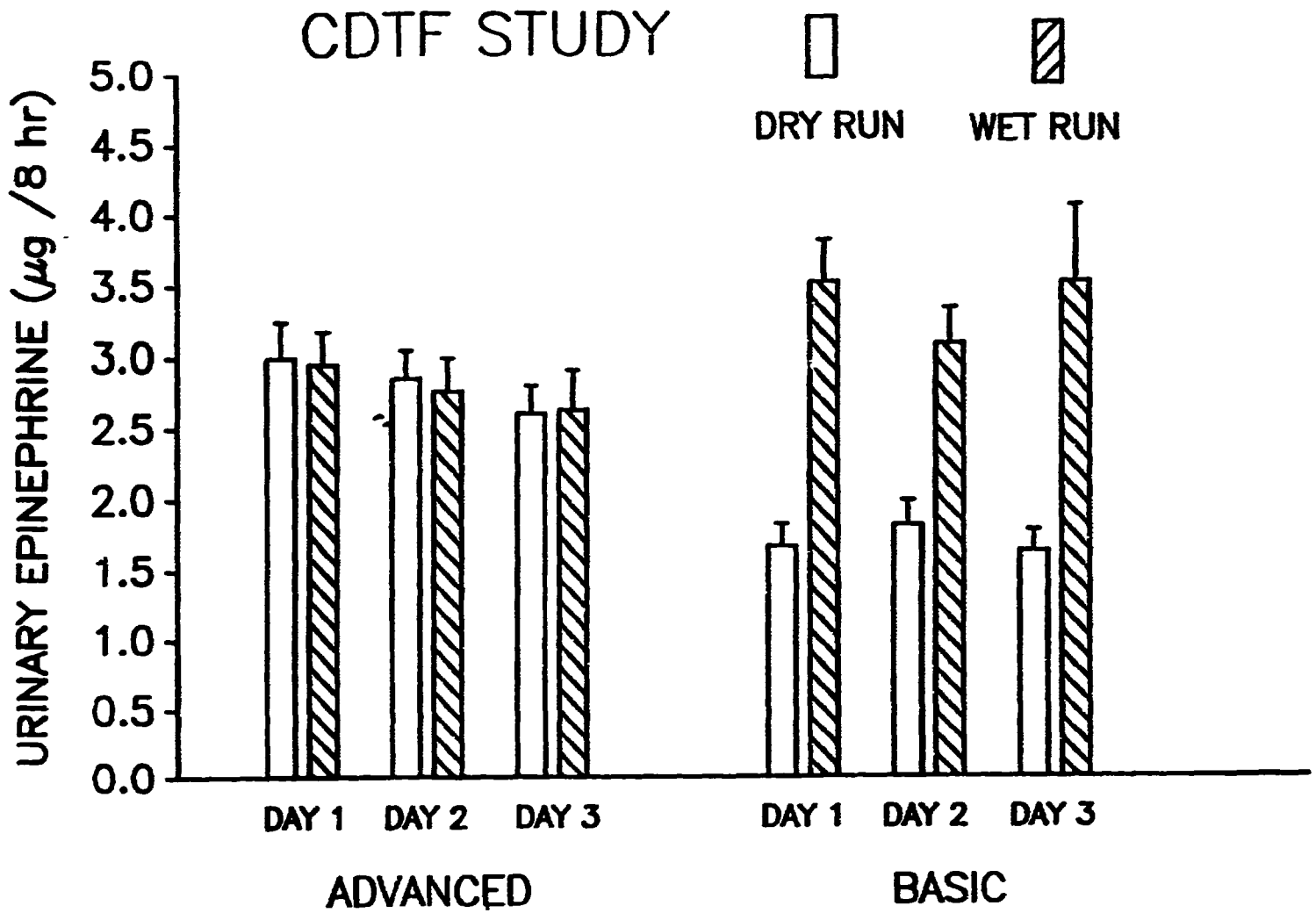


● BLOOD PRESSURE, HEART RATE, MOOD

▲ BLOOD

★ URINE (OVERNIGHT)

Figure 2



Significant F ($p < .01$) for agent, agent x experience

Figure 3

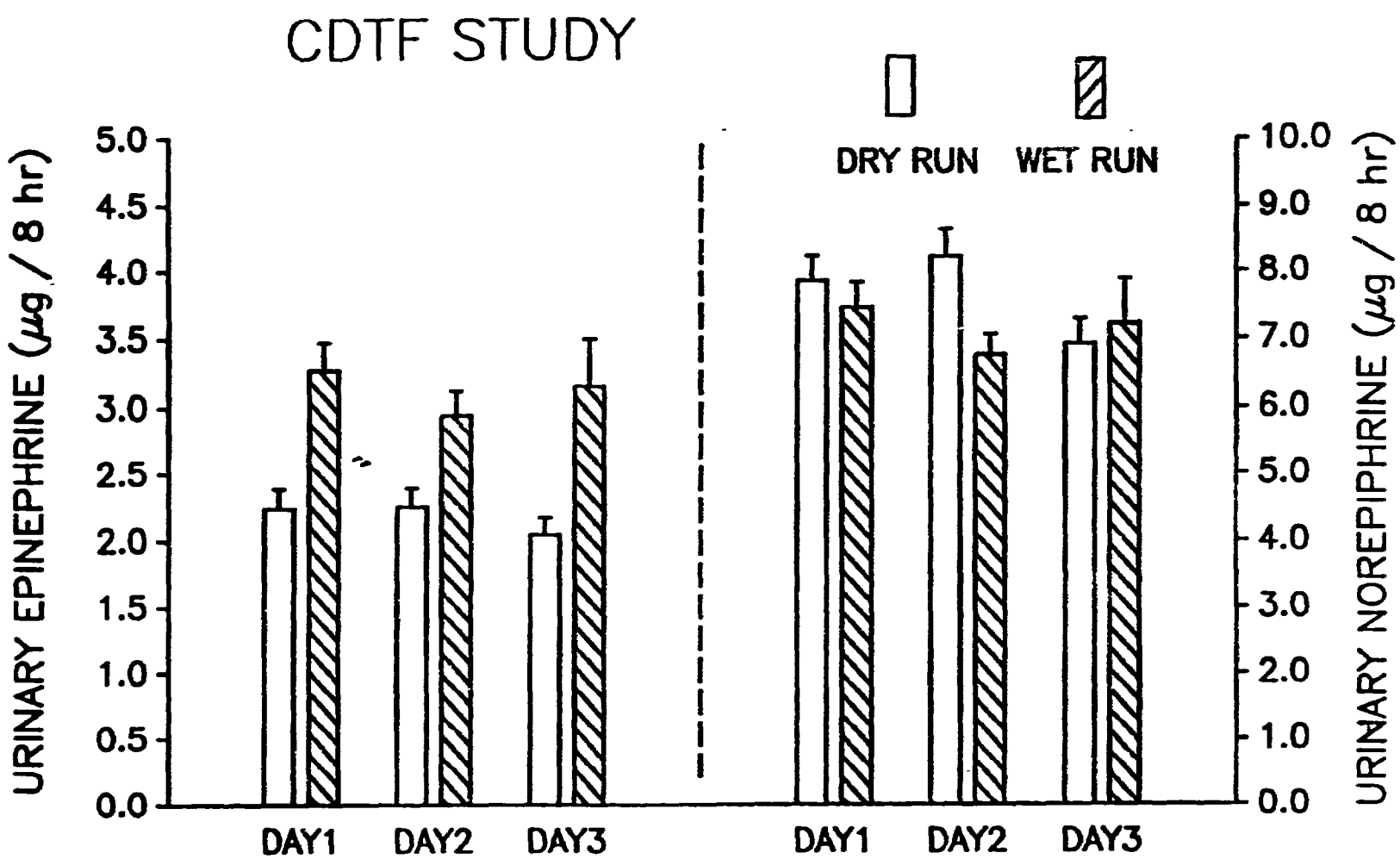
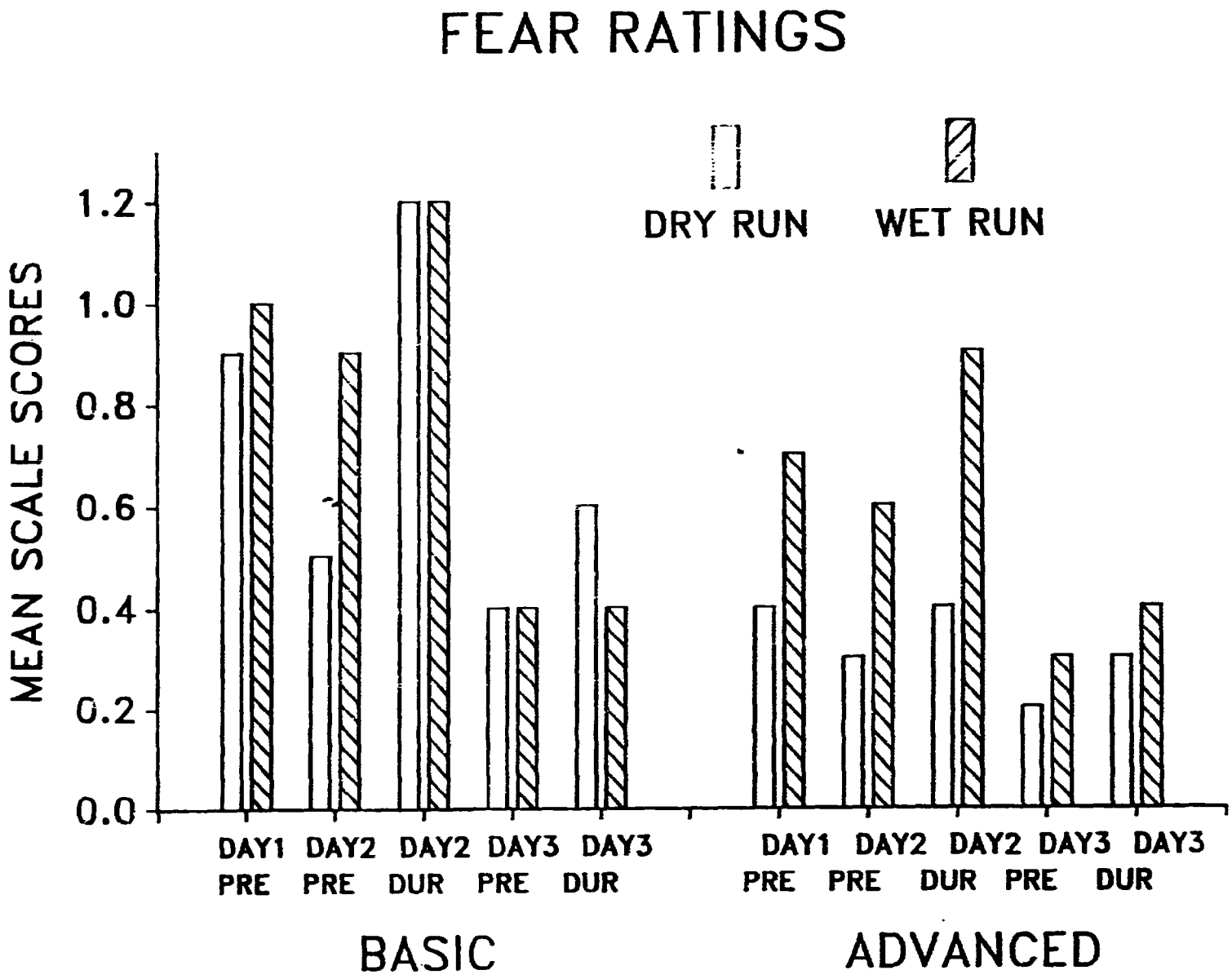
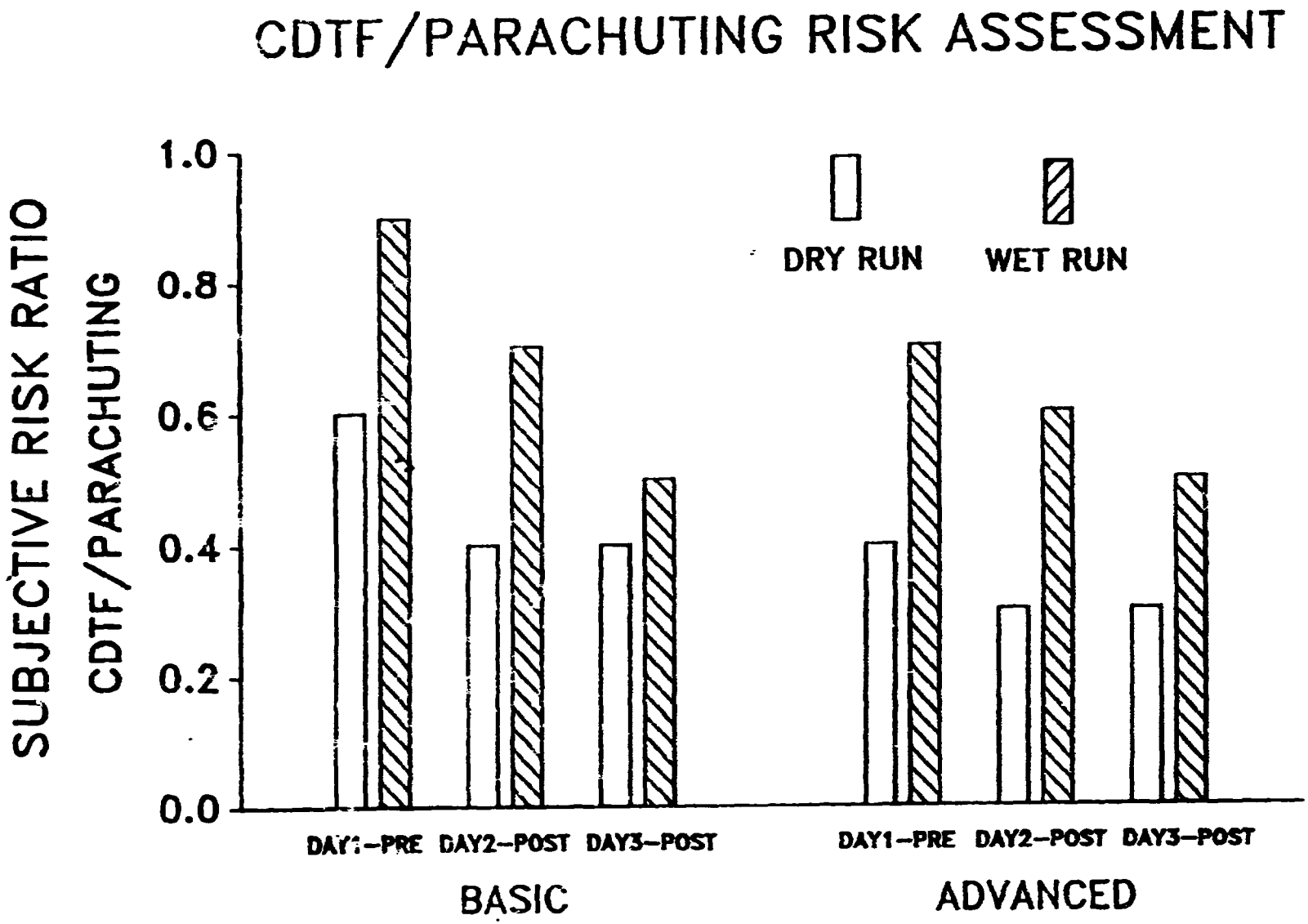

CDTF STUDY
DRY RUN
WET RUN
URINARY EPINEPHRINE (µg / 8 hr)
URINARY NOREPIPHRINE (µg / 8 hr)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
DAY1
DAY2
DAY3
DAY1
DAY2
DAY3

Figure 4


FEAR RATINGS
DRY RUN
WET RUN
MEAN SCALE SCORES
1.2
1.0
0.8
0.6
0.4
0.2
0.0
DAY1 PRE
DAY2 PRE
DAY2 DUR
DAY3 PRE
DAY3 DUR
DAY1 PRE
DAY2 PRE
DAY2 DUR
DAY3 PRE
DAY3 DUR
BASIC
ADVANCED

Figu 5


CDTF/PARACHUTING RISK ASSESSMENT
SUBJECTIVE RISK RATIO
CDTF/PARACHUTING
1.0
0.8
0.6
0.4
0.2
0.0
DRY RUN
WET RUN
DAY1-PRE
DAY2-POST
DAY3-POST
BASIC
DAY1-PRE
DAY2-POST
DAY3-POST
ADVANCED

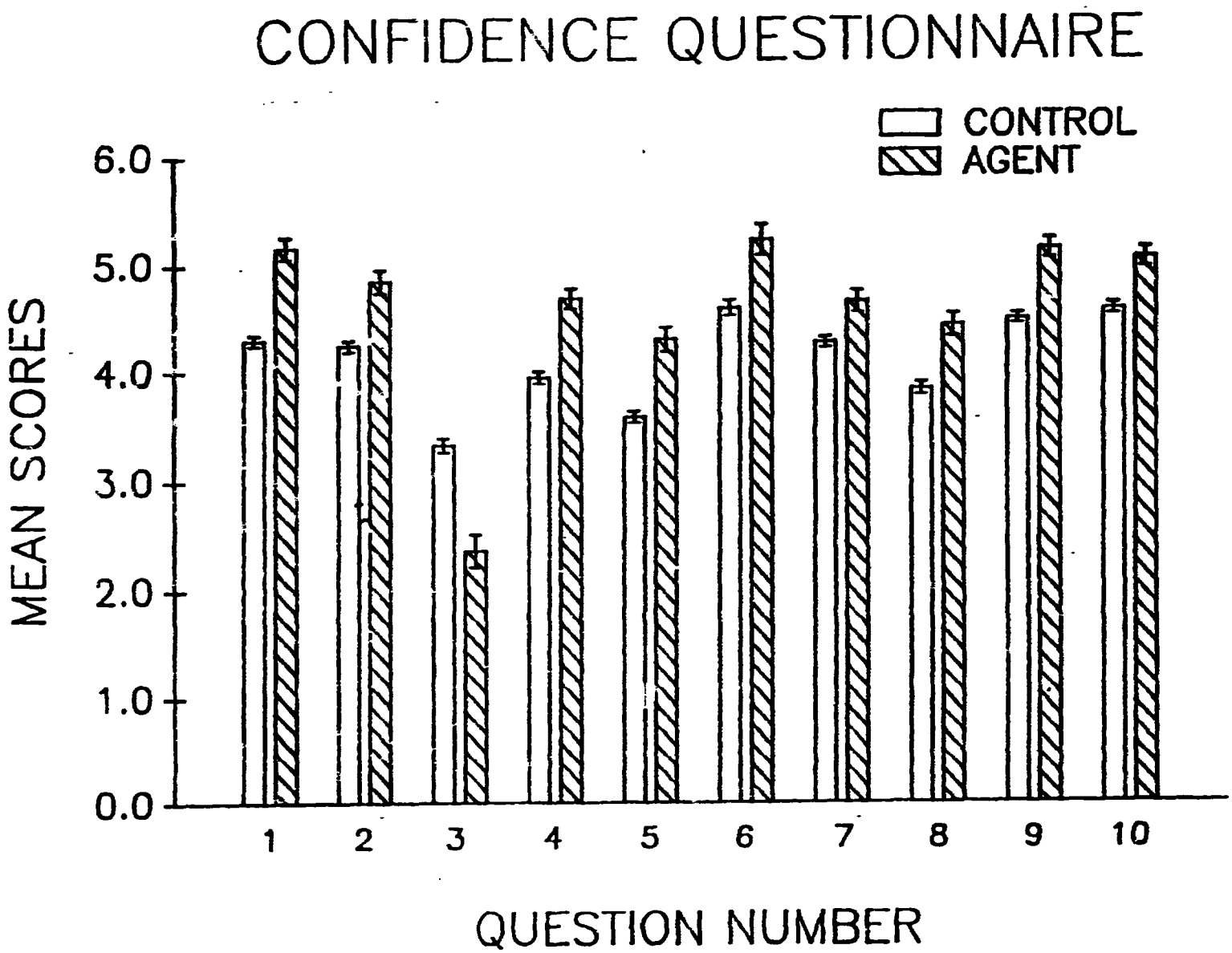
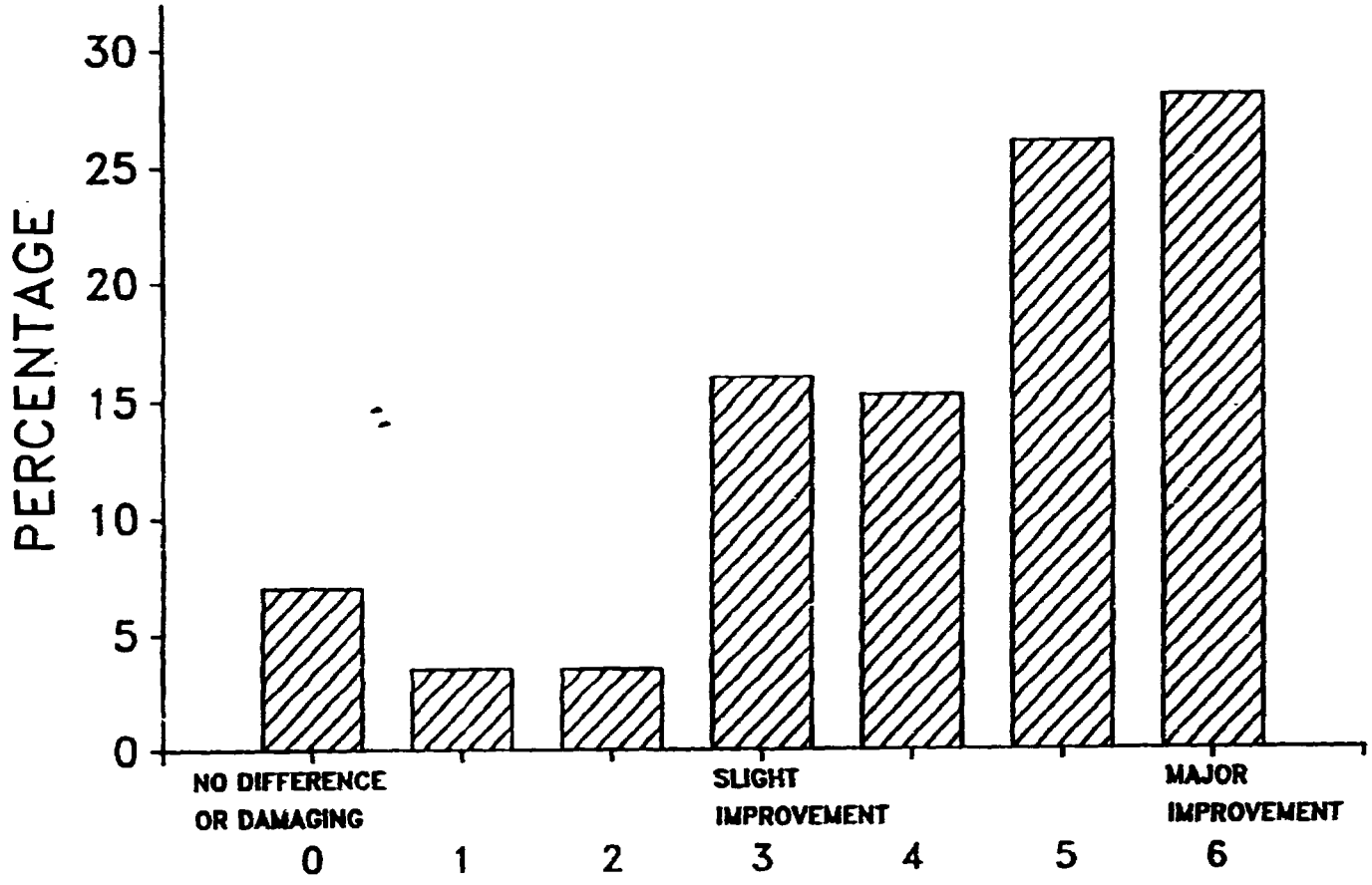

CONFIDENCE QUESTIONNAIRE
CONTROL
AGENT
MEAN SCORES
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1
2
3
4
5
6
7
8
9
10
QUESTION NUMBER

Figure 7

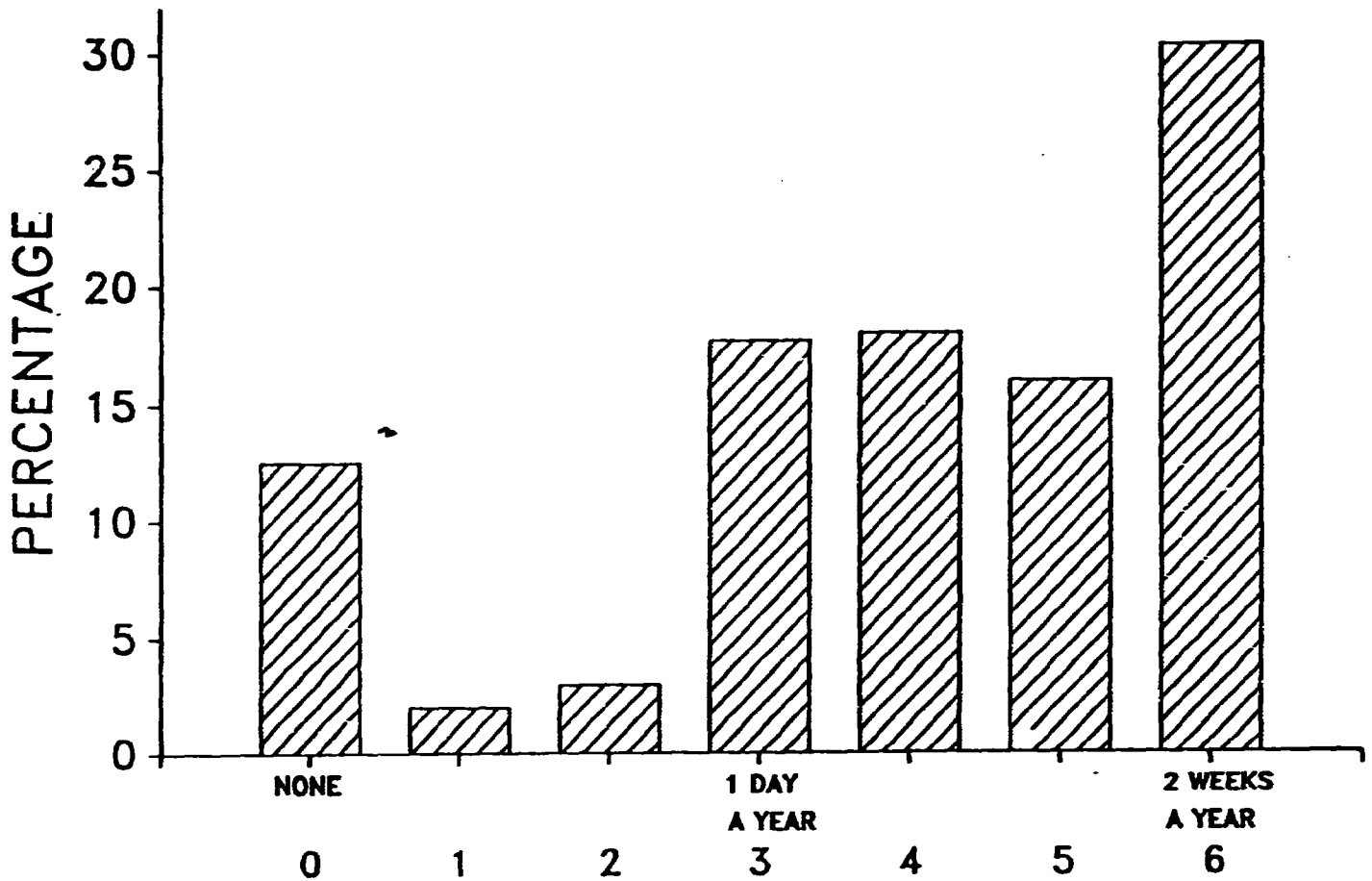
CREDIBILITY QUESTIONNAIRE



"WOULD CHEMICAL CORPS NCO'S AND OFFICERS TRAINED WITH LIVE AGENT ENHANCE THE OVERALL COMBAT EFFECTIVENESS OF YOUR UNIT ?"

Figure 8

CREDIBILITY QUESTIONNAIRE



"HOW MUCH OF YOUR UNIT'S TRAINING TIME WOULD YOU GIVE UP TO OBTAIN LIVE AGENT'S TRAINING FOR YOUR SOLDIERS ?"

APPENDIX I

CONFIDENCE QUESTIONNAIRE

Please answer each question by circling the number, from zero to six, which best shows your opinion.

1. How will MOPP IV (mask, suit, gloves, boots) protect you during a chemical attack in combat?

0	1	2	3	4	5	6
Quite Poorly						Very Well

2. How has your training prepared you to perform in a chemical attack in combat?

0	1	2	3	4	5	6
Quite Poorly						Very Well

3. How many of your Ft. McClellan classmates will panic the first time they face a major chemical attack?

0	1	2	3	4	5	6
Hardly Anybody						Nearly Everybody

4. How would you perform your mission in MOPP IV during a chemical war?

0	1	2	3	4	5	6
Quite Poorly						Very Well

5. How do you think your Ft. McClellan classmates will perform their assignments in MOPP IV during a chemical war?

0	1	2	3	4	5	6
Quite Poorly						Very Well

6. What do you think of the value of using actual chemical warfare agents such as GB or VX in Army training?

0	1	2	3	4	5	6
Nearly Worthless						Essential

7. How effectively will your classmates instruct soldiers outside the Chemical Corps to operate successfully on a chemical battlefield?

0	1	2	3	4	5	6
Quite Poorly						Very Well

HOW WOULD YOUR FT. MCCLELLAN CLASSMATES PERFORM THE FOLLOWING TASKS WHILE IN MOPP IV DURING COMBAT?:

8. Provide first-aid if you became a chemical casualty?

0	1	2	3	4	5	6
Quite Poorly						Very Well

9. Identify different chemical agents?

0	1	2	3	4	5	6
Quite Poorly						Very Well

10. Decontaminate equipment you would later use?

0	1	2	3	4	5	6
Quite Poorly						Very Well

Please indicate whether you are male (M) or female (F)

APPENDIX 2

CREDIBILITY QUESTIONNAIRE

Please answer each question by circling the number from zero to six which best shows your opinion.

CHEMICAL CORPS PERSONNEL WILL SOON BEGIN OCCASIONAL TRAINING EXERCISES WITH LIVE CHEMICAL AGENTS ("NERVE GAS"). PLEASE ANSWER THESE QUESTIONS IN TERMS OF YOUR MOST RECENT COMBAT ARMS ASSIGNMENT.

1. Would Chemical Corps NCO's trained with live agent do a better job of training your soldiers to fight on a chemical battlefield?

0	1	2	3	4	5	6
no difference or damaging			slight improvement			major improvement

2. Would Chemical Corps NCO's and officers trained with live agent improve the chance of your unit surviving a first attack with chemical weapons?

0	1	2	3	4	5	6
no difference or damaging			slight improvement			major improvement

3. Would Chemical Corps NCO's and officers trained with live agent enhance the overall combat effectiveness of your unit?

0	1	2	3	4	5	6
no difference or damaging			slight improvement			major improvement

4. Would Chemical Corps NCO's and officers trained with live agent increase the confidence of soldiers in your unit?

0	1	2	3	4	5	6
no difference or damaging			slight improvement			major improvement

5. How much of your unit's training time would you give up to obtain live agent training for your soldiers?

0	1	2	3	4	5	6
none			one day a year			two weeks a year

6. How would your soldiers respond if they faced a major chemical attack -- today?

0	1	2	3	4	5	6
Panic, Unit breakup			Moderate Confusion			Minimal Disruption

7. If your unit survived a major chemical attack, today, how effectively could it fight afterward in MOPP IV on a dirty battlefield?

0	1	2	3	4	5	6
Barely Functional			Moderately Effective			Highly Successful

What is your rank?

What is your branch?

What is your current assignment?

APPENDIX 3a
MOOD QUESTIONNAIRE

Last four SSN digits:

Date:

Class: E10 NCO OB OA

Session: 1A 1B 2A 2B 3A 3B

For each word, please circle the number beside it which best shows how well that word DESCRIBES YOUR FEELINGS RIGHT NOW.

	Not At All						Very Much So
MISERABLE	0	1	2	3	4	5	6
UNEASY	0	1	2	3	4	5	6
INACTIVE	0	1	2	3	4	5	6
ENERGETIC	0	1	2	3	4	5	6
BLUE	0	1	2	3	4	5	6
GROUCHY	0	1	2	3	4	5	6
LIVELY	0	1	2	3	4	5	6
GOOD	0	1	2	3	4	5	6
MEAN	0	1	2	3	4	5	6
ANNOYED	0	1	2	3	4	5	6
DEPRESSED	0	1	2	3	4	5	6
ALARMED	0	1	2	3	4	5	6
INSECURE	0	1	2	3	4	5	6
WEARY	0	1	2	3	4	5	6
ALERT	0	1	2	3	4	5	6
LAZY	0	1	2	3	4	5	6
CONTENTED	0	1	2	3	4	5	6
CHEERFUL	0	1	2	3	4	5	6
SAD	0	1	2	3	4	5	6
DOWNCAST	0	1	2	3	4	5	6
SATISFIED	0	1	2	3	4	5	6
ANGRY	0	1	2	3	4	5	6
LOW	0	1	2	3	4	5	6
AFRAID	0	1	2	3	4	5	6

	Not At All						Very Much So
BURNED UP	0	1	2	3	4	5	6
DROWSY	0	1	2	3	4	5	6
CALM	0	1	2	3	4	5	6
IRRITATED	0	1	2	3	4	5	6
JITTERY	0	1	2	3	4	5	6
VIGOROUS	0	1	2	3	4	5	6
PLEASED	0	1	2	3	4	5	6
ACTIVE	0	1	2	3	4	5	6
HAPPY	0	1	2	3	4	5	6
STEADY	0	1	2	3	4	5	6
HOPELESS	0	1	2	3	4	5	6
SLUGGISH	0	1	2	3	4	5	6

How well did you sleep last night?

0	1	2	3	4	5	6
very badly for me			average for me			very well for me

Please imagine the MOST RISKY OR DANGEROUS activity a person could possibly do. Think of that activity as one end of the scale below, and a completely no-risk activity as the other end. Please mark the letter "P" below the number which best shows how risky you think PARACHUTE JUMPING is. Please mark the letter "C" below the number which best shows how risky you think this week's CDTF exercise is.

0	1	2	3	4	5	6	7	8	9	10
No risk at all										The most risky activity I can imagine

APPENDIX 3b

MOOD QUESTIONNAIRE

Last four SSN digits:

Date:

Class: E10 NCO OB OA

Session: 1A 1B 2A 2B 3A 3B

For each word, please circle the number beside it which best shows how well that word DESCRIBES YOUR FEELINGS IN THE MASK CHECK ROOM AND DURING YOUR FIRST FEW MINUTES IN THE FACILITY'S "HOT" AREA.

	Not At All						Very Much So
MISERABLE	0	1	2	3	4	5	6
UNEASY	0	1	2	3	4	5	6
INACTIVE	0	1	2	3	4	5	6
ENERGETIC	0	1	2	3	4	5	6
BLUE	0	1	2	3	4	5	6
GROUCHY	0	1	2	3	4	5	6
LIVELY	0	1	2	3	4	5	6
GOOD	0	1	2	3	4	5	6
MEAN	0	1	2	3	4	5	6
ANNOYED	0	1	2	3	4	5	6
DEPRESSED	0	1	2	3	4	5	6
ALARMED	0	1	2	3	4	5	6
INSECURE	0	1	2	3	4	5	6
WEARY	0	1	2	3	4	5	6
ALERT	0	1	2	3	4	5	6
LAZY	0	1	2	3	4	5	6
CONTENTED	0	1	2	3	4	5	6
CHEERFUL	0	1	2	3	4	5	6
SAD	0	1	2	3	4	5	6
DOWNCAST	0	1	2	3	4	5	6
SATISFIED	0	1	2	3	4	5	6
ANGRY	0	1	2	3	4	5	6
LOW	0	1	2	3	4	5	6
AFRAID	0	1	2	3	4	5	6

	Not At All						Very Much So
BURNED UP	0	1	2	3	4	5	6
DROWSY	0	1	2	3	4	5	6
CALM	0	1	2	3	4	5	6
IRRITATED	0	1	2	3	4	5	6
JITTERY	0	1	2	3	4	5	6
VIGOROUS	0	1	2	3	4	5	6
PLEASED	0	1	2	3	4	5	6
ACTIVE	0	1	2	3	4	5	6
HAPPY	0	1	2	3	4	5	6
STEADY	0	1	2	3	4	5	6
HOPELESS	0	1	2	3	4	5	6
SLUGGISH	0	1	2	3	4	5	6

How well did you sleep last night?

0	1	2	3	4	5	6
very badly for me			average for me			very well for me

Please imagine the MOST RISKY OR DANGEROUS activity a person could possibly do. Think of that activity as one end of the scale below, and a completely no-risk activity as the other end. Please mark the letter "P" below the number which best shows how risky you think PARACHUTE JUMPING is. Please mark the letter "C" below the number which best shows how risky you think this week's CDTF exercise is.

0	1	2	3	4	5	6	7	8	9	10
No risk at all										The most risky activity I can imagine

VOLUNTEER AGREEMENT AFFIDAVIT

For use of this form, see AR 40-38; the proponent agency is the Office of the Surgeon General

THIS FORM IS AFFECTED BY THE PRIVACY ACT OF 1974

1. AUTHORITY: 10 USC 3012, 44 USC 3101 and 10 USC 1071-1087.

2. PRINCIPAL PURPOSE: To document voluntary participation in the Clinical Investigation and Research Program. SSN and home address will be used for identification and locating purpose.

3. ROUTINE USES: The SSN and home address will be used for identification and locating purposes. Information derived from the study will be used to document the study; implementation of medical programs; teaching; adjudication of claims; and for the mandatory reporting of medical condition as required by law. Information may be furnished to Federal, State and local agencies, as appropriate.

4. MANDATORY OR VOLUNTARY DISCLOSURE: The furnishing of SSN and home address is mandatory and necessary to provide identification and to contact you if future information indicates that your health may be adversely affected. Failure to provide the information may preclude your voluntary participation in this investigational study.

PART A - VOLUNTEER AFFIDAVIT

VOLUNTEER SUBJECTS IN APPROVED DEPARTMENT OF THE ARMY RESEARCH STUDIES

Volunteers under the provisions of AR 70-25 are authorized all necessary medical care for injury or disease which is the proximate result of their participation in such studies.

I, _____ (last, first, middle) SSN _____ having full capacity to consent and having attained my _____ birthday, do hereby volunteer to participate in An Evaluation of Stress, Confidence and Performance Associated with the USA Chemical School's Decontamination Training Facility (research study) under direction of C. FREDERICK TYNER, COL, MC conducted at FT. MCCLELLAN, AL (name of institution).

The implications of my voluntary participation; the nature, duration and purpose of the research study; the methods and means by which it is to be conducted; and the inconveniences and hazards that may reasonably be expected have been explained to me by C. Frederick Tyner, COL, Dir, Div of Neuropsychiatry, WRAIR/WRAMC, Wash., DC 20307-5100 (202) 576-3556/3006 (AV 291-3556/3006).

I have been given an opportunity to ask questions concerning this investigational study. Any such questions were answered to my full and complete satisfaction. Should any further questions arise concerning my rights on study-related injury I may contact JUDGE ADVOCATES OFFICE at FT. MCCLELLAN, AL 36205-5020 (205) 238-5435 (AV 865-5435) (name and address of hospital & phone number (include area code))

I understand that I may at any time during the course of this study revoke my consent and withdraw from the study without further penalty or loss of benefits however, I may be ☐ required (military volunteer) or ☐ requested (civilian volunteer) to undergo certain examination if, in the opinion of the attending physician, such examinations are necessary for my health and well-being. My refusal to participate will involve no penalty or loss of benefits to which I am otherwise entitled.

PART B - TO BE COMPLETED BY INVESTIGATOR

INSTRUCTIONS FOR ELEMENTS OF INFORMED CONSENT: (Provide a detailed explanation in accordance with Appendix E, AR 40-38 or AR 70-25.)

1. The purpose of this research is to asssess the stressfulness and effectiveness of the three day training exercise at the Chemical Decontamination Training Facility. The research is not part of the actual CDTF training. Therefore, should you refuse to consent, you still will be required to complete the scheduled CDTF training on the course POL. You will not, however, be involved in the additional medical research studies described here, which will accompany portions of the training.

Volunteering to participate in this study will involve the following:

i. answering questionnaires (8 times in three days).
ii. having your heart rate and blood pressure measured (8 times in three days).
iii. giving an overnight urine specimen (before each of the three days).
iv. giving one tube (10 c.c's) of blood (5 times in three days).
v. wearing a heart rate monitor (all morning for the three mornings).
vi. wearing an activity monitor (for 6 days before and during the training).

SECURITY CLASSIFICATION OF THIS PAGE

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Stress, Confidence, Performance and Credibility Produced by Toxic Agent Training at the Chemical Decontamination Training Facility (U)

PERSONAL AUTHOR(S)
TYNER, C. Fred, MANNING, Frederick J., OLESHANSKY, Marvin A.

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This evaluation measured the stress associated with a training exercise involving chemical warfare agents and tested whether the exercise changed the confidence, credibility or performance of those taking it. The on-site evaluation included over 100 subjects for all tests and over 1000 for some. An additional part of the study addressing credibility was conducted away from the training site during the same approximate time and involved 240 non-Chemical Corps subjects. Biomedical, questionnaire, and behavioral measures of stress were not in strong agreement, but on the whole supported the conclusion that the training exercise was mildly stressful. Questionnaire measures of confidence related to working on a chemically contaminated battlefield were clearly higer for subjects trained with toxic agent than for subjects without such training. Combat Arms Officers and NCOs were strongly in favor of such training for their own units as well as the Chemical Corps, suggesting that the exercise will enhance the credibility of graduates.

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SECURITY CLASSIFICATION OF THIS PAGE

3. The information gathered from this study will allow the investigators to analyze psychological, physiological and hormonal factors involved in the normal response of healthy soldiers to a training exercise involving chemical warfare agents. Previous studies have shown that situations such as this are associated with changes in heartrate, blood pressure and the release of hormones.

4 There is a small risk of hypotension (decrease in blood pressure) resulting in passing out or fainting during insertion of the needle for the blood sample. This usually is self limited with no serious adverse emergencies. You are not expected to suffer any major discomforts beyond a possible hematoma (bruise or temporary black and blue mark) or minor infection at the site of insertion of the intravenous needle. No precautions need to be observed before or after the study with the exception that persistent redness or tenderness the insertion site should be examined by a physician for possible infection.

5. You may not benefit directly from this study but the study may contribute to more effective training for future students in the Chemical School. The time spent in support of this project will be recognized through a letter of appreciation.

6. You are expected to inform the principal investigators if you have any medical problems or are taking any medication. Individuals with medical problems or who are taking medications or drugs which might interfere with interpreting the test results will be excluded from the study.

7. You should understand that participation in this study is voluntary and if you refuse to enroll or decide to leave the study at any time, this will no way count against you or have any effect on your graduation from this course. If you decide to withdraw from the study, you are expected to inform the principal investigator directly. Such withdrawal removes you only from the medical research aspects described above. It does <u>not</u> remove you from the actual CDTF training itself. That training is a requirement for graduation from your course of instruction.

8. Confidential records will be available only to the investigators actively participating in the study and representatives of the U.S. Army Research and Development Command. In all publications and presentations resulting from this research study, no reference will be made to you and your identity will be treated as medically confidential.

9. This study will consist of approximately 300 volunteers.

_____ _____

Signature Date

APPENDIX C

Presentation to ADPA Conference 4 December 1991, Summation of Doctoral Dissertation, Smith, Paula S. "The Effects of Training with Lethal Chemicals on Job Proficiency and Job Confidence"

THE EFFECTS OF TRAINING WITH LETHAL CHEMICALS ON JOB PROFICIENCY AND JOB CONFIDENCE

DR. PAULA S. SMITH

U. S. ARMY CHEMICAL SCHOOL

Paper presented at the meeting of the American Defense Preparedness Associaton, Fort McClellan, Alabama, December 1991.

The Effects of Training with Lethal Chemicals on Job Proficiency and Job Confidence

Chemical warfare causes great physical and even greater psychological damage on the battlefield. History has shown that panic and psychosomatic reactions are genuine hazards on the chemically contaminated battlefield and on a battlefield soldiers believe to be chemically contaminated. Extensive research and development have provided the soldier of today with protective garments, detection, identification, and decontamination equipment far superior to that used by soldiers in past conflicts. The requirement to train soldiers to survive and to operate on a battlefield which may have a chemical environment is not a new one. However, with the formidable threat presented by chemical warfare today, the training need continues to escalate in importance.

Strengthening the soldiers' confidence in their equipment as well as increasing their proficiency in its use is the primary objective of the chemical agent training conducted at the Chemical Defense Training Facility (CDTF) at Fort McClellan, Alabama. While wearing full chemical protective gear, soldiers learn to detect, to identify, and to decontaminate chemical agents. Soldiers trained in this facility earn the MOS (54B) as a Chemical Operations Specialist and, upon graduation, become the trainers within their assigned commands.

The CDTF is the first facility of its kind in the Free World, and it is believed to be the only one of its kind in the world. The facility is designed so that training is conducted in large bays, maintained at a negative pressure, to ensure environmental protection. While training in this facility, students go through three training exercises. The first consists of a mock contamination exercise using simulants on the facility's outdoor training pads. The second exercise, held in one of the small training bays in the CDTF, affords soldiers the opportunity to detect, to identify, and to decontaminate chemical agents on small weapons. In the third exercise, soldiers go through a more thorough exercise in which they detect and identify an agent on an armored reconnaissance vehicle. Once the agent has been identified, soldiers use equipment to decontaminate the vehicle.

Until the development of the CDTF, soldiers trained in open air in an agent-free environment. Under certain conditions simulants were used to activate detection and identification equipment. Training in the CDTF enables soldiers to work in an environment which contains lethal chemical agents. These agents are GB, a hazardous nerve agent vapor, and VX, a thickened liquid nerve agent hazardous to touch. U.S. Army trainers believe that the more realistic training provided by the CDTF at Fort McClellan provides the Army with chemical specialists who are more proficient in the use of their equipment and more confident in their own ability to survive and to perform their mission in the event of a chemical attack. This study was designed to study the stress and the physiological and psychological effects on soldiers trained in the CDTF and to determine if soldiers trained using chemical agents are in reality more proficient and confident.

Null hypotheses tested were:

1. There are no significant differences in the levels of job confidence in their ability to survive of soldiers trained in an environment where lethal chemical agents are used and of those not so trained.

2. There are no significant differences in the levels of job proficiency of soldiers trained in an environment where chemical agents are used and of those not so trained.

3. There are no significant differences in the levels of perceived and measured stress of soldiers trained in an environment where lethal chemical agents are used and of those not so trained.

Methods

Subjects

Group 1, the treatment group, was composed of 150 soldiers. Group 2, the control group for the facility, was made up of 30 soldiers. Group 3, the control group for the training treatment, was composed of 158 soldiers.

While the demographic composition of each class was not exact, it was extremely close. The mean age was 20.72 for the treatment group, 20.40 for the facility control group and 20.53 for the training control group. The mean education level was 12.10 for the treatment group, 12.11 for the facility control group, and 12.01 for the training control group. There were very little differences in the classes with regard to gender, race, or military component.

Procedure

All soldiers in this study completed basic training and were undergoing the Advanced Individual Training required for the award of MOS 54B. This course was 16 weeks and 2 days in length.

The blocks of instruction being evaluated were taught during the fourth to seventh weeks of advanced training. The first block of instruction centered on the detection, identification, and behavior of chemical agents. The second and third blocks of instruction dealt with the operation, maintenance, and procedures involved in deliberate and hasty decontamination of items contaminated with chemical agents. These instructional blocks culminated in a special training exercise.

Group 1, the treatment group, completed the exercise in the CDTF where chemical agents were used. The soldiers who made up Group 1 were aware since the beginning of training that chemical agents would be used in this exercise.

Because the CDTF is an imposing building, Group 2, the control group for the facility, served to determine how much of the additional

effect of training in this environment was from the facility and how much was actually from the chemical agent. The culminating exercise for these soldiers took place in the facility but without the presence of a chemical agent. The soldiers knew from the beginning that they would train in this facility but would not train with chemical agents.

Group 3, the control group for the training, completed the decontamination exercise in full protective gear in an open training area. The decontamination exercise took place in an environment that was free of chemical agents. The soldiers who made up this group knew since the beginning of training this exercise would culminate their training and that the environment would be agent free.

Soldiers in the three groups were not assigned randomly but were studied in the classes to which they were assigned. None were preselected. Classes used in this study were identified only by their being ready for the block of training on chemical agent identification and decontamination at the time the facility was ready to use for training. An effort was made to ensure that classes were comparable in their demographic composition and in the capabilities and background of their students.

Soldiers were not specifically selected to participate in the chemical treatment nor were they specifically selected for the other groups. The training control group, Group 3, soldiers were the first classes to be trained in MOS 54B during fiscal year 1987. Once the CDTF construction was completed and the Chemical School was ready to try out the facility, the classes undergoing the decontamination block began training in the facility. These classes made up Group 2. Further tests of the facility were made, and, upon certification of its environmental safety, the chemical environment was added as another treatment in training. Classes were phased in as they came to this block of training. The first classes of advanced individual training soldiers to go through the facility began their training on 14 April 1987. Classes trained in the CDTF from 14 April to 30 September 1987 made up Group 1.

Evaluation of the proficiency of the soldiers as a result of these blocks of training was with the administration of existing written end-of-block examinations. No change to the examination or method of administration occurred while evaluating the three groups.

Confidence was evaluated with a questionnaire written by a board of military researchers especially for this study. It consisted of 10 questions, to be answered on a 7-point Likert scale, which addressed the soldiers' confidence in their own ability and in the ability of their classmates to survive a chemical attack, to identify agents, and to decontaminate equipment. This questionnaire was given to the students immediately following the culminating practical exercise at the end of the third block of instruction. It was given to each group in exactly the same manner and at the same point in the training cycle.

Stress was evaluated and substantiated by a team of medical researchers from the US Army Research and Development Command, Walter

Reed Army Medical Center. Stress was determined through biomedical measures including blood pressure and heart rate readings, blood hormones (cortisol and ACTH), and overnight urinary hormones (cortisol and adrenalines--epinephrine and norepinephrine) and through mood questionnaires assessing how soldiers perceived their stress levels. The mood questionnaires were analyzed to provide indices of fear, anger, depression, fatigue, activity, and happiness. Stress evaluations were contrasted between Group 2 and the first class of Group 1. No information as to stress levels was obtained on Group 3 subjects or the remaining classes of Group 1.

Blood pressure readings were taken eight times during the 3-day practical exercise. Heart rate was collected with a 4-lead battery powered portable recording system (Medilog) worn under the uniform by subjects from 0630 until the conclusion of the exercise each day. The times were correlated and the readings for eight designated periods were used for the study. Blood samples were taken five times by the facility nurse and overnight urine samples were taken three times. Mood questionnaires were administered eight times during the training by the team from Walter Reed Army Medical Center.

Facility

The Chemical Defense Training Facility complex consists of an administration building for office space and two classrooms, a small guard house, three outdoor simulant training pads, and a main training building. The main building has nine filtration units. In addition there are also three liquid waste holding tanks, a hazardous waste incinerator, and a solid waste holding building.

The main training building has a medical aid station, a chemical laboratory, male and female locker rooms, a laundry-equipment maintenance area, and a safety control room. A large training bay, capable of holding a large tracked vehicle (tank), and six small bays complete the floor plan.

Equipment

Subjects entering the facility were dressed in chemical protective clothing consisting of a protective overgarment (jacket and trousers), butyl rubber overboots, butyl rubber gloves with cotton lining inserts, and an M17 protective mask with hood.

Equipment used in the detection and identification process included the M8A1 chemical agent alarm and the M256 chemical agent detector kit. As the nerve agent was poured over the equipment, the vapor set off the M8A1 chemical agent alarm indicating the presence of a chemical agent. Subjects then, with the aid of their M256 chemical agent detector kits, determined which chemical agents were present.

The decontamination of the equipment was accomplished by the application of Decontaminat ng Solution 2 (DS2) to the contaminated areas of the equipment. The DS2 was applied by using the M11

decontaminating apparatus and the M13 decontaminating apparatus, portable.

Instruments

The instruments used to evaluate proficiency were the existing end-of-block written tests. These written tests consisted of multiple-choice items dealing with chemical agents, their detection, identification, and the methods used for decontamination. The equipment test consisted of 34 multiple-choice items. The agent detection and identification test consisted of 20 multiple-choice items. The decontamination test consisted of 24 multiple-choice items.

Test items were validated using the normal Army validation procedure as detailed in TRADOC Regulation 351-6. Validation involved try-out of the test items in individual and small groups trials. Participants in these trials were both soldiers who could and could not perform the actual task being tested. Each question was evaluated using a Phi coefficient. After each test item was validated, it was used in the actual class for a minimum of three iterations. After the test had been given three times, a reliability determination was made. Test reliability coefficients as computed using the Kuder-Richardson 20 formula. Reliability coefficients for the equipment test, for the agent detection and identification test, and for the decontamination test were .78, .79, and .81 respectively.

Confidence was evaluated with a questionnaire written especially for this study. It consists of 10 questions to be answered on a 7-point Likert scale. Each question on the questionnaire is valued based on the points selected on the 7-point scale. Scores range from 1 to 7 on each question with a possibility of 10 to 70 points on the entire questionnaire. Higher scores denote greater confidence on the part of the individual completing the questionnaire. Validation of this questionnaire was accomplished in the same manner as the proficiency test validation. The confidence questionnaire had an internal consistency reliability of .8376.

Perceived stress was evaluated by an existing Army questionnaire used frequently to determine stress reactions when training. The questionnaire asks for a determination of how the individual is feeling at the time of the questionnaire in relation to 30 descriptive words. The internal consistency reliability for the mood questionnaire was .72.

Analyses and Results

An analysis of variance using Scheffe' multiple comparison tests was used to evaluate confidence. The independent variables were the treatment conditions. The treatment conditions were either performance of an exercise in the CDTF where chemical agents were used (Group 1-treatment), performance of an exercise in simulated contamination in the CDTF (Group 2-facility control), or performance of an exercise in simulated contamination at an outdoor site (Group 3-training control). The dependent measure was the self rating of job confidence.

As shown in Table 1, a significant difference was discovered between Group 1 and both Groups 2 and 3. The null hypothesis that there are no significant differences in the levels of confidence in their ability to survive in soldiers trained in an environment where chemical agents are used and in those not so trained was rejected. Job confidence was significantly higher in soldiers trained in an environment where chemical agents were used.

Insert Table 1 about here

An analysis of variance using Scheffe' multiple comparison tests was also used to evaluate job proficiency. The independent variables were again the three treatment conditions. The dependent measures were three written tests to determine proficiency.

There were no significant differences in levels of job proficiency of the soldiers in the three conditions as measured by the written tests. The null hypothesis that there were no significant differences in the levels of job proficiency of soldiers trained in an environment where chemical agents are used and of those not so trained could not be rejected.

The evaluation of stress was with a repeated measures analysis of variance with differences between the group means over time for significant interaction tested with a 1 degree of freedom F-test. No multiple comparisons were made for within group factors when interaction of Treatment x Time were not significant. The independent measures were the treatment conditions and time. The treatment conditions for this part of the study were performance of an exercise in the CDTF when chemical agents were used and performance of an exercise in a simulated chemically contaminated environment in the CDTF. The dependent measures were the stress measures of fear, fatigue, anger, depression, happiness, activity, and risk of training as perceived by the soldiers and reported through a mood questionnaire; and the biomedical measured stress factors of heart rate readings, systolic and diastolic blood pressure readings; urinary cortisol, epinephrine and norepinephrine readings; and serum ACTH and cortisol readings.

Stress is measured not by a change in a single self-evaluation measure or by a change in a single biomedical level reading, but rather as a result of changes in multiple readings and self-evaluations. Therefore, determination would not be based on a significant effect in any one area but in a combination of significant effects both in the area of mood self-evaluation and in the heart rate and in the levels of blood pressure reading and urinary and serum endocrine readings. The seven items from the mood questionnaire represent perceived stress measured through self-evaluation of the soldiers while the eight biomedical measures represent physical changes to the body of the soldiers. The significance of each item from the seven-item mood

questionnaire and the eight-item biomedical measure were examined independently.

Stress measurement is a most difficult area to define because of the interrelationship of all measured areas. Additionally, it is important to determine whether stress being measured had a physical or psychological cause. As a result of the analysis, there were significant differences in the self-rating in the area of activity. Additional physical stress for the treatment was confirmed by the significant diastolic blood pressure, epinephrine, and norepinephrine readings. The significant differences in heart rate in period 8 further confirms increased activity. There are significant differences as an interaction of Treatment x Time in heart rate readings in periods 2 and 8 and in ACTH readings in periods 1, 4, and 5. There were also significant differences in the interaction of Treatment x Time in systolic blood pressure readings; however, no one period was identified as significant. The ACTH increase would tend to indicate anxiety during these periods; however, without significant differences in any of the other areas, which would indicate anxiety, this cannot be confirmed. Increases in heart rate readings and systolic pressure can be the result of either physical or psychological stress.

Tables 2 and 3 summarize those null hypotheses which are rejected and those which are not rejected.

Insert Table 2 about here

Insert Table 3 about here

One significant finding was in the area of perceived risk of training. No significant differences in the levels of perceived risk of training were identified across time. There are significant differences in the levels of perceived risk within the group at the various testing times. The interaction of Treatment x Time is also significant.

The ANOVA summary data for the self-evaluation of risk of training are shown in Table 4.

Insert Table 4 about here

Because there is a significant interaction of Treatment x Time, a further comparison of the means was necessary to determine in what time

periods there were significant differences. Significant differences were found in the first four time periods with the means for the treatment group being significantly higher than the means for the stress control group. The comparison of the means for perceived risk of training are shown in Table 5.

Insert Table 5 about here

Conclusions

As a result of the analyses there is no confidence that the treatment has affected job proficiency. There is confidence that soldier confidence has been increased.

The most significant finding was in the area of perceived risk of training. The risk was perceived as significantly higher in the first four evaluations; it was not perceived as significantly risky in the later evaluations. There is confidence that training in the contaminated environment reduced the soldiers perceived risk of training.

If the purpose of the CDTF is to reassure soldiers that their protective gear does protect them from a chemical agent, that their detection equipment does detect chemical agents, and that items contaminated with a chemical agent can be decontaminated, then training in the CDTF is a success. Results of this study show that soldiers training in the CDTF have the perception that they are better able to survive in combat and to perform their mission in the event of a chemical attack. With this confidence, soldier stress on the battlefield should be lessened in the event of an actual chemically contaminated battlefield.

Table 1

ANOVA Summary for
Job Confidence

Source	SS	df	MS	F	Significance
Between subjects	3366.45	2	1683.22	34.30	.000
Within subjects	16438.04	335	49.07	--	--

Table 2

Biomedical Stress Measures

Measures	Decisions		
	Between subjects	Within subjects	T x T
Heart rate	NR	R	R
Systolic blood pressure	NR	R	R
Diastolic blood pressure	R	R	NR
Urinary cortisol	NR	NR	NR
Urinary epinephrine	R	NR	NR
Urinary norepinephrine	R	NR	NR
Serum ACTH	R	R	R
Serum cortisol	NR	R	NR

Table 3

Self-Rated Stress Measures

Measures	Decisions		
	Between subjects	Within subjects	T x T
Fear	NR	R	NR
Fatigue	NR	R	NR
Anger	NR	NR	NR
Depression	NR	R	R
Happiness	R	R	NR
Activity	R	R	NR
Risk of training	NR	R	R

Table 4

ANOVA Summary for Risk of Training

Source	SS	df	MS	F	Significance
Between subjects	2093.12	51	41.04	--	--
Group	148.37	1	148.37	3.62	.063
Within subjects	661.05	357	1.85	--	--
Time	162.84	7	23.26	12.56	.000
Group x Time	51.88	7	7.41	4.00	.000

Table 5

Comparison of Means for
Risk of Training

Time	Difference between means	F	Significance
1	1.99	7.70	yes
2	1.91	7.10	yes
3	1.73	5.82	yes
4	1.88	6.88	yes
5	.78	1.18	no
6	.42	.34	no
7	.41	.33	no
8	.39	.30	no

APPENDIX D

Analysis of FY91 CDTF Student Questionnaires

APPENDIX D

Analysis of FY91 CDTF Student Questionnaires

1. CDTF Post Training Survey Results.

a. We looked at the Student Critique Sheets from approximately 2700 students who were trained in the CDTF during FY 91. A sample questionnaire (Student Critique sheet) is at Tab A. In particular we concentrated on questions 4 and 5. We used question 4 as a measure of how the student felt about his/her own abilities to perform in an NBC environment. We used question 5 as a measure of the student's confidence in his equipment to protect him and enable him to continue the mission in an NBC environment.

b. Because the questionnaire is open ended and does not have a scaled response, we considered the student's response as to whether or not they felt more confident in their ability or their equipment after CDTF training as opposed to before training. A response that had specific words such as "better, more, higher,...etc" we considered as an improvement in the student's confidence. We counted only these students in the total for the Improve category. A response that had terms such as "worse, more worried, poor training, ...etc" we considered as a worsening of the student's confidence. If a student had a comment that expressed low or high confidence but no mention of how CDTF training had affected their confidence, we considered it a neutral response. All students with these latter two type of comments were totaled in the Not Improve category. The end result (table at Tab B) was the number of students by type class that felt the training had either improved or not improved their confidence.

c. The percent of improved confidence for each class is the number that felt their confidence had improved divided by the total number responding to the question. Note that these numbers reflect a perceived improvement in confidence not a measure of absolute confidence. We do not have data to say what the confidence level of the students was prior to their doing the CDTF training. To get the error bounds we used standard techniques for determining the error in estimating the proportion of a population. [Statistical Techniques in Business and Economics, Robert D. Mason, 1970 Revised Edition, Richard D. Irwin Inc., pages 208-217].

d. The graphs at Tab C show the same information that is in the table at Tab B. The graph titled "NBC Performance Confidence" is the information from question 4 and the graph titled "NBC Equipment Confidence" is the information from question 5. All types of students showed an increase in confidence for both their own performance and that of their

equipment with the percentage of increase varying between the classes. The Xs are the expected (average) percentages of students who felt their confidence had increased and the vertical lines show the range in which we would expect the percentage increase to fall 95% of the time. Classes where the error bounds do not overlap are assumed to have a statistically different percentage of students whose confidence increased. Classes where the error bounds overlap are not statistically significantly different. For example, on question 4 the OSUT and BNCOC classes are different (higher) than the ANCOC classes whereas the ANCOC, COBC and USMC classes are not different.

e. From an initial look at the descriptive statistics in the graphs, it would also appear that students experience a greater boost of confidence in their equipment than in their own ability to function in an NBC environment. However, to confirm the hypothesis of a different percentage increase for each question would require a different technique looking at each questionnaire on a student by student basis.

2. CDTF Results versus CANE Test Results.

a. One set of non-live agent training results that can be compared to the CDTF questionnaire is found in Tab D - Technical Memorandum ORI-TM-7-87, "Demographics, Training, and Player Opinion Data for the Combined Arms in Nuclear/Chemical Environment Force Development Test and Experimentation IIA (CANE FDTE IIA)". Mean Responses to Post-test Questions (UT02) of the referenced document is presented here as Tab D. This questionnaire was a scaled response survey with 1 being very low confidence and 5 being very high confidence. The graph at Tab D shows the same data graphically. The Xs are the mean response on the scale and the vertical bars show the mean plus and minus one standard deviation as reported in the ORI publication. As we can see by the large degree of overlap, this graph shows that the expected confidence after training does not show a statistically significant difference from the confidence before training.

b. The other table, Figure 1-3 in the original document, at Tab D is also extracted from the ORI report. Note that in the bottom portion of the table the Bradley Fighting Vehicle (BFV) Commanders and tank Commanders questioned did not show a large increase in confidence after the field test as opposed to before the field test. The very low sample sizes, 7 and 18, make this data very unreliable; however, the data do not clearly show the marked increase in confidence that we are seeing with the CDTF training.

DATE_____

STUDENTS'S CRITIQUE SHEET

COURSE_____ CLASS_____ STUDENT'S NAME/RANK_____

INSTRUCTOR'S NAME/RANK_____

COMMENT ON THE FOLLOWING TOPICS

1. Instructor Knowledge/Teaching Techniques:_____

2. Training Aids/Actual Equipment used:_____

3. Was the training challenging enough: No/Yes (explain):_____

4. How do you now feel about working in a chemically contaminated environmer

5. Are the capabilities of the detection and decontamination equipment adequate? (explain):_____

6. How would you improve the training?_____

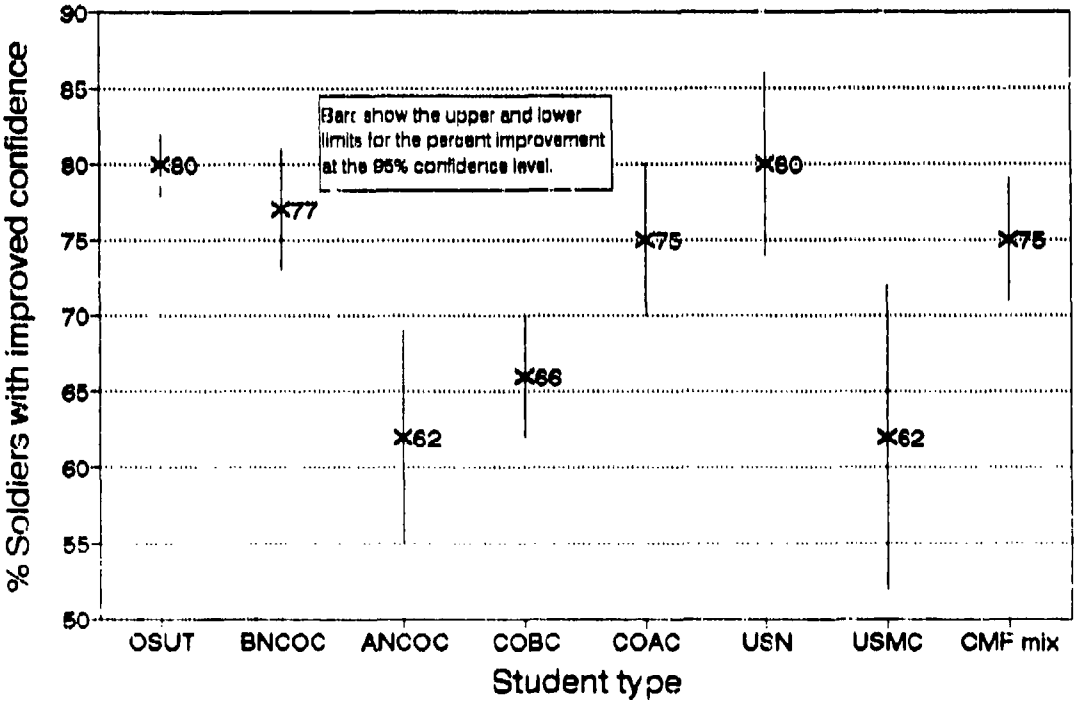
7. Additional comments (i.e. Safety, Time allowed):_____

Data for questions 4 and 5 on the questionnaire.

	Question 4: Improvement in performance confidence.					Question 5: Improvement in equipment protection confidence.				
response population	Improve	Not improve	percent of improve	error bounds at 95% confidence high	low	Improve	Not improve	percent of improve	error bounds at 95% confidence high	low
OSUT	904	220	80	82	78	1022	53	95	96	94
BNCOC	284	83	77	81	73	317	49	87	90	84
ANCOC	88	53	62	69	55	91	41	69	76	62
COBC	227	115	66	70	62	261	64	80	84	76
COAC	172	57	75	80	70	186	50	77	82	72
USN	109	27	80	86	74	116	18	87	92	82
USMC	44	27	62	72	52	51	11	82	90	74
CMF mix	303	99	75	79	71	340	49	87	90	84
Question total	2131	681	76	77	75	2364	335	88	89	87

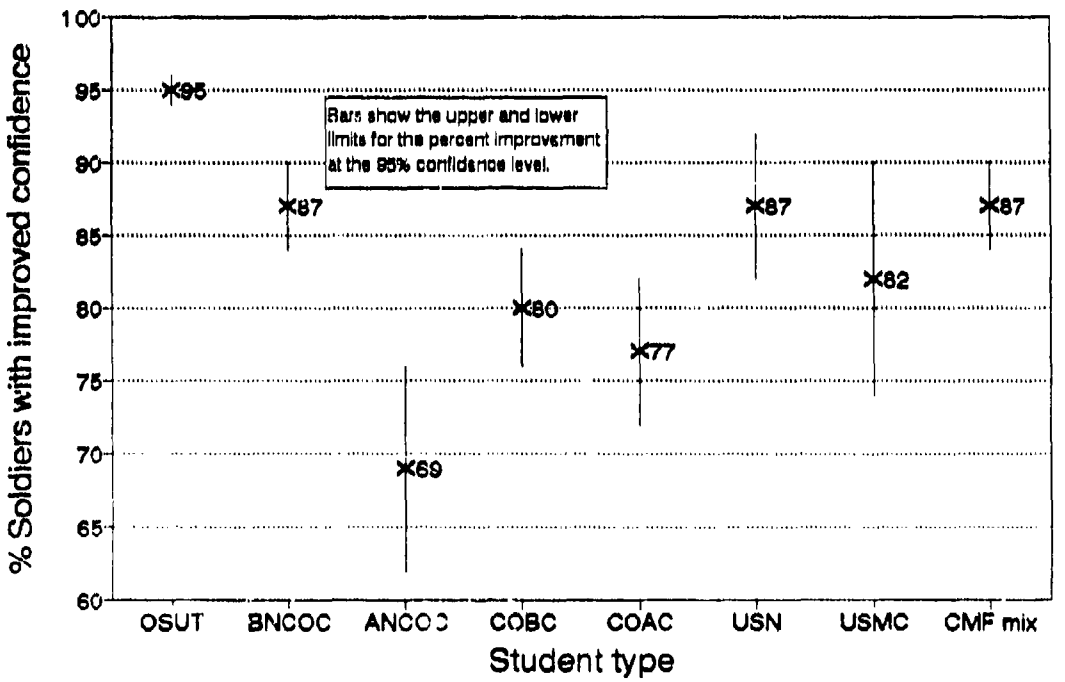
NBC Performance Confidence

After CDTF Tng vs Before CDTF Trig



NBC Equipment Confidence

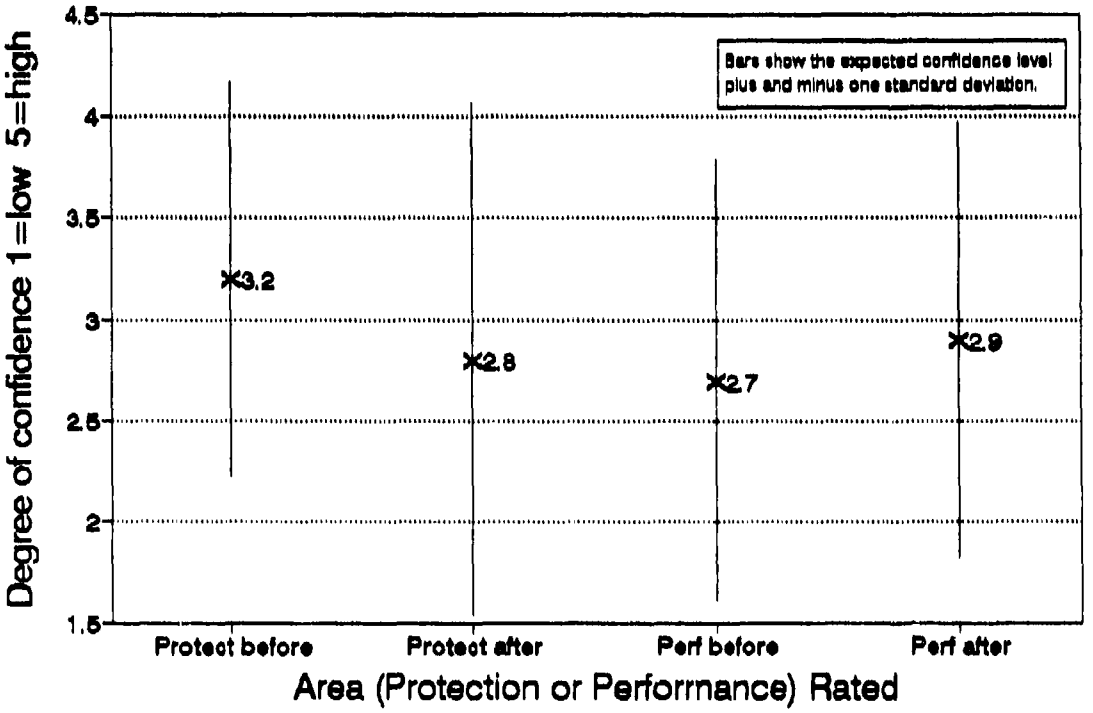
After CDTF Tng vs Before CDTF Tng



TAB C. Mean Responses to Posttest Questions (UT02)

		Response Scale		11M (BFV)	11H (ITV)	11C (Mortar)	Total Inf
Q01	Before test: Confidence in MOPP 4 gear protection	Very low to Very high 1 - 5	n Mean sd	33 3.5 0.97	15 3.1 0.59	37 2.9 1.00	85 3.2 0.97
Q02	After test: Confidence in MOPP 4 gear protection	Very low to Very high 1 - 5	n Mean sd	33 2.9 1.35	15 3.5 0.52	37 2.4 1.26	85 2.8 1.26
Q02 minus Q01	Change in confidence: MOPP 4 gear protection	Down 4 to Up 4 -4 to +4	n Mean sd	33 -0.6 0.97	15 0.5 0.74	37 -0.4 0.87	85 -0.3 0.96
Q03	Before test: Confidence in performance while in MOPP 4	Very low to Very high 1 - 5	n Mean sd	33 2.9 1.09	15 2.9 0.99	37 2.5 1.10	85 2.7 1.08
Q04	After test: confidence in performance while in MOPP 4	Very low to Very high 1 - 5	n Mean sd	33 2.8 0.98	15 3.5 0.83	37 2.7 1.16	85 2.9 1.07
Q04 minus Q03	Change in confidence: Performance in MOPP 4 gear	Down 4 to Up 4 -4 to +4	n Mean sd	33 0.0 1.08	15 0.6 1.18	37 0.1 0.79	85 0.15 0.99
Q05	Effect of CANE ing on job performance:	None to Lg impr 1 - 3	n Mean sd	33 2.1 0.82	15 2.6 0.51	37 1.8 0.66	85 2.1 0.75

Confidence in Protection or Performance
After CANE Test vs Before CANE Test



questionnaires and 65 respondents to the posttest questionnaires were classified as leaders. Since the posttest questionnaires were anonymous, identifying the same individuals from both data sets was impossible. The respondents for the two questionnaires are assumed to be primarily the same individuals. Separate analyses of leaders for each group are presented in the sections addressing those groups.

One comparison across leader groups was made between the Bradley Fighting Vehicle (BFV) commanders (infantry) and the tank commanders (armor). As seen in Figure 1-3, tank commanders, compared to BFV commanders, had been in the

BFV Vehicle Commanders and Tank Commanders (Enlisted only): Selected Information

Demographics & Training

Vehicle	Median time in Service (Q12)	Median time in Unit (Q10)	Closed-Hatch Tng w/Unit (Q20A)	Tng in NBC Detection (Q21)	MOPP 4 Tng w/Unit (Q22)	Consec Hrs in MOPP 4 (Q23)
BFV Cdrs (n=6)	6 yrs	19 mos	83% Yes	50% more than 10 hrs	33% more than 10 hrs	50% more than 3 hrs
Tank Cdrs* (n=17)	9 yrs	13 mos	71% Yes	65% more than 10 hrs	65% more than 10 hrs	47% more than 3 hrs

Posttest Opinions

Vehicle	Confidence in MOPP 4 protection		Confidence in performance in MOPP 4		Reduction in job performance due to MOPP 4	
	Before test (Q01)	After test (Q02)	Before test (Q03)	After test (Q04)	12 hrs (MOPP 4) (Q19)	72 hrs (varying MOPP) (Q18)
BFV Cdrs (n=7)	71% Very low to Moderate	71% Very low to Moderate	100% Very low to Moderate	86% Very low to Moderate	72% Large to very large	71% Large to very large
Tank Cdrs* (n=18)	72% Very low to moderate	67% Very low to moderate	61% Very low to moderate	72% Very low to moderate	44% Large to very large	89% Large to very large

* Includes all enlisted leaders except 1st SGT

Figure 1-3. BFV Vehicle Commanders and Tank Commanders (Enlisted Only): Selected Information

APPENDIX E

Analysis of 24th Infantry Division Questionnaires

VICTORY DIVISION
March 2, 1992

Dear General Orton:

Enclosed are results of the Chemical Defense Training Facility (CDTF) survey. Results track closely with the reports received when the Division's leaders and soldiers came back from the CDTF. Then and now, they wholeheartedly value the opportunity to train with actual agents, real detectors/alarms and real decontaminants.

The presence of CDTF trained soldiers in every company of the Division directly improves our combat readiness. These soldiers have great confidence that their equipment works. Your training program is right on target.

Sincerely,

Enclosure

Barry R. McCaffrey
Major General, U.S. Army
Commanding

Brigadier General Robert D. Orton
Commandant
U.S. Army Chemical School
Fort McClellan, Alabama 36205-5020

APPENDIX E

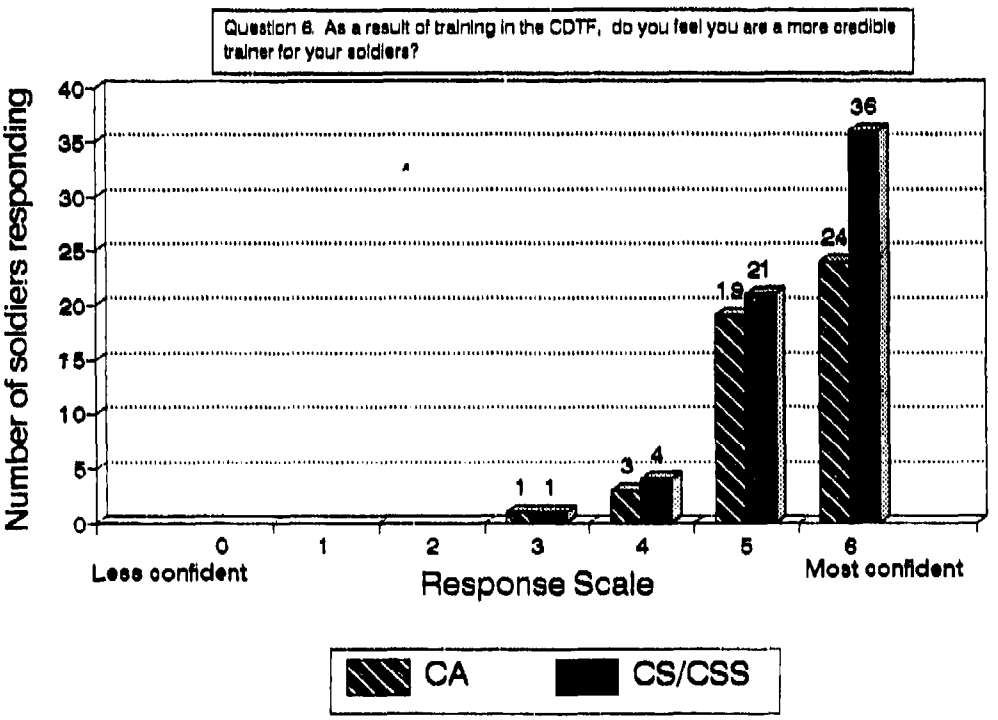
24TH ID (M) Survey Questionnaire

1. To get information from a field unit regarding CDTF training and its influence on soldier confidence, we sent a scaled response questionnaire (Tab A) to the 24th ID (M), at Ft. Stewart, GA. We received a response from 113 soldiers with four soldiers not answering the questions regarding their own CDTF experiences. The survey is a scaled response type with the scale going from 0 = Less Confident to 6 = Most Confident.

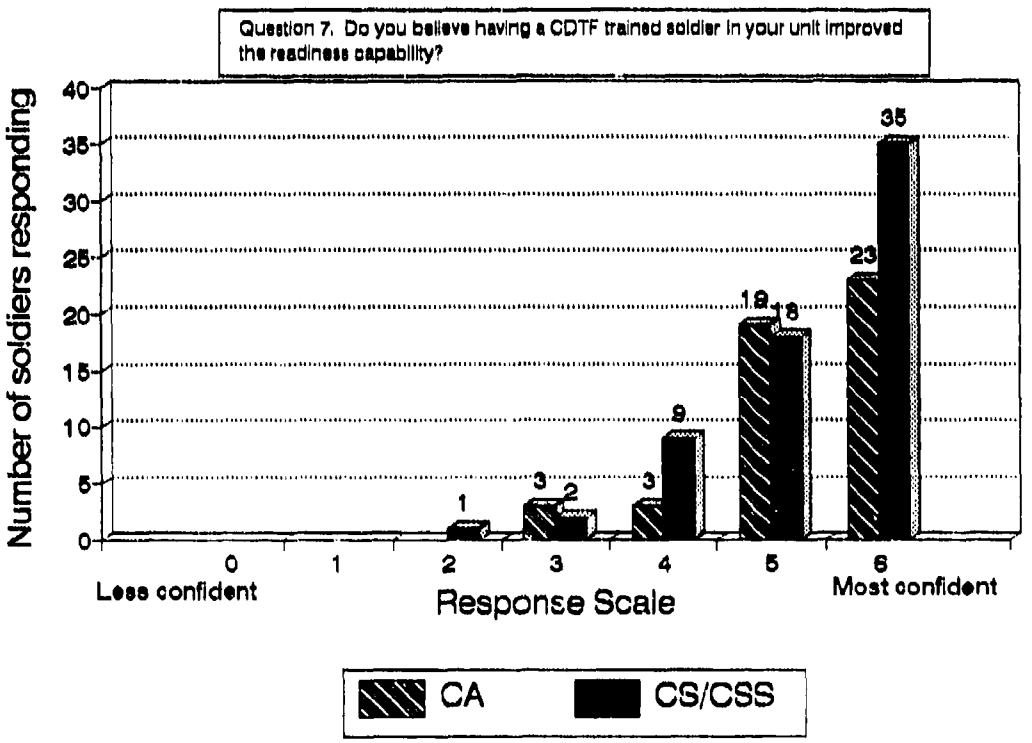
2. The bar charts at Tab B show the responses to question 6 (credibility) and question 7 (readiness) on the questionnaire. The responses are grouped by Combat Arms (CA) and Combat Support/Combat Service Support (CS/CSS) branches to include officers and enlisted. Note that for both questions, the responses are skewed towards the Most Confident end of the scale. These data confirm our earlier results showing an increase in confidence on the CDTF student critique sheet (questionnaire). The 24th ID (M) results also show that, in addition to increased confidence, the soldiers feel that CDTF training makes them more credible as trainers and materially improves their unit's readiness.

3. To see if there was a difference in responses between the CA and CS/CSS branches, we performed a chi-squared test for the responses to questions 6 and 7. Because there were so few responses in the Less Confident range, we grouped the responses into those between 0-5 and those at 6 on the scale. The chi-squared test showed no significant difference between the responses for the CA and CS/CSS branched soldiers. Both CA and CS/CSS soldiers feel they and their units benefit from CDTF training.

24th ID Response to Questionnaire
Credibility and Readiness Questions



24th ID Response to Questionnaire
Credibility and Readiness Questions



1. How will MOPP IV (mask, suit, gloves, boots) protect you during a chemical attack?

0 1 2 3 4 5 6
Very Poorly Very Well

2. How well will detection equipment (M8A1, CAM, M256A1, M8/M9 Paper) work in a chemical attack?

0 1 2 3 4 5 6
Very Poorly Very Well

3. How well will decon equipment (M13, M11, M258A1) perform to neutralize chemical agents?

0 1 2 3 4 5 6
Very Poorly Very Well

4. As a result of training in the CDTF, did you feel more confident in your ability to survive in a chemical environment?

0 1 2 3 4 5 6
Less Confident Most Confident

5. As a result of training in the CDTF, did you feel more confident in your ability to perform your mission in a chemical environment?

0 1 2 3 4 5 6
Less Confident Most Confident

6. As a result of training in the CDTF, do you feel you are a more credible trainer for your soldiers?

0 1 2 3 4 5 6
Less Confident Most Confident

7. Do you believe having a CDTF trained soldier in your unit improved the readiness capability?

0 1 2 3 4 5 6
Less Confident Most Confident

APPENDIX F

CDTF Anecdotal Summary

APPENDIX F

CDTF Anecdotal Summary

The CBR Analysis Plan, published 1 April 1974 stated "Because of lack of material and lack of qualified and trained personnel, the US Army is vulnerable to a CB attack. The overall state of CBR readiness in the US Army is poor. A reversal in the trend to de-emphasize CBR must occur if this readiness is to improve. The success of a program to reemphasize CBR defense training hinges on the ability of the Army to change attitudes concerning the need for this type of training." To this end the US Army made two major decisions - (1) to establish an E-5 staff NCO at Company level to provide the commander with a continuous source of NBC expertise and (2) Establish a Chemical School with adequate training facilities. "The use of live agents (toxic chemical agents) in training was evaluated in response to DA. The use of toxic chemical agents is considered absolutely essential to realistic CW/BC defense training." (Revitalization Studies, "Chemical School Establishment", 4 February 1977.)

Thus the major purpose for the development of the Chemical Defense Training Facility (CDTF) at Fort McClellan was to enable soldiers to experience working in a toxic environment. By working in this environment and experiencing the "real thing" the Chemical School believes that the fear of the unknown will be greatly reduced and replaced with confidence, that their equipment works. Furthermore, it is imperative that soldiers be convinced of the tremendous importance of using their survival, detection and identification, and decontamination equipment correctly.

General Norman Schwarzkopf, in his testimony before the Committee on Armed Services, United States Senate, One Hundred Second Congress, First Session, expressed his great concern over the tremendous impact the use of chemical weapons would have when he stated, "But I have to tell you one of my biggest concerns from the outset was the psychological impact of the initial use of chemical weapons on the troops. If they fight through it, then it is no longer ever going to be a problem. But if it stops them dead in their tracks and scares them to death, that is a continuing problem. And that was one of the concerns we had all along."

It has been contended that good training will overcome this fear regardless of what environment this is conducted in - regular training, training with simulants, or toxic agent training. This contention is **NOT** supported by the numerous comments received by soldiers, from Private to General Officer, after training in the CDTF.

General Maxwell Thurman, when Commander Training and Doctrine Command (TRADOC), underwent CDTF training. He claimed that nothing in his entire Army training had prepared him for the real thing.

This is the attitude most commonly recorded. One Army Reserve Colonel, after attending the CDTF as part of the Senior Commander Conference, said, "I question whether we are training our soldiers adequately. Good/Excellent course! Should be required for all senior commaders and staff officers. CDTF training is a need for all soldiers." This is also echoed by a National Guard Combat Arms General Officer who said, "(CDTF) Outstanding, removed a lot of fear with work on live agents." And a Combat Service Support USAR General Officer who said, "(CDTF) I'm comfortable with it for the first time. Excellent, I enjoyed it, well worth my time."

If General Officers are comfortable for the first time as a result of training with toxic agents, imagine how much more the training reassures the initial entry soldiers. One of the one station unit training (OSUT) students summed up the goal by saying, "Anytime I run into a chemical environment and come out unhurt it was a challenge." Another OSUT student reaffirmed that idea, "If you are nervous, everything is harder to accomplish than it seems. I'm very confident because I know all the equipment works, namely 'The Mask'."

An additional value comes from the opportunity to see the variety of equipment actually work in this environment. One Private put it very well "It was very helpful to be put in an active chemical environment and work with the actual M258A1 (sic), M256A1 (sic) kits and other decon apparatus." And when asked about the adequacy of equipment another soldier said "The capabilities are adequate, because the M8, M9, M258, and M256 did the job on detection, identification, and decontamination." One Colonel, when asked what single idea or concept he would remember from the Senior Commander Course CDTF training responded by saying "How difficult it is to operate in a Chem Environment, BUT -- It can be done."

Another benefit in training in toxic agent is that the use of live chemical agents has the advantage of presenting teaching objectives indelibly to the trainees. Here at the Chemical School it is frequently observed that when students work with simulant agents, they neither remember or follow all the measures outlined in instruction. The emphasis soldiers put on paying attention and following procedures is best reported by two OSUT soldiers who said, "It had me thinking at every point;" and "You had to pay attention or you could of screwed up!"

The Revitalization Study, 4 February 1977 found that "While in chemical protective clothing, the students, to enhance their personal comfort, would deliberately compromise the protective clothing, i.e., lift the mask, open the protective clothing. This could well be fatal or casualty producing in an actual contaminated environment. Deliberate compromise of protective clothing was never known to occur when live agents were incorporated in the training exercises and safety procedures were nearly always strictly adhered to." Over and

over, soldiers after CDTF training comment on how difficult it was to keep the mask on and not break the seal when they begin to feel claustrophobic. One soldier said "I never knew an itch on your face could be so much trouble. I had to force myself to remember I was in the real agent and not lift my mask."

The threat of chemical war is not lessening - quite the contrary. In October 1990, General Vuono, then Chief of Staff of the Army, said "This facility (CDTF) permits unique chemical defense training during a time when chemical weapons proliferation and increased threat of use makes it essential." Gen (Ret) Frederick J. Krossen stated in Chemical Warfare - A Real and Growing Threat, "A decision to employ American military forces almost anywhere in the world cannot be made today without cognizance of the fact that they could be subject to chemical attack." We have just experienced the threat of chemical warfare in Operation Desert Storm. General Schwarzkopf and others have stated that Saddam Hussein's chemical and biological facilities and delivery systems made the possibility of their use an ever real danger. No one knows for sure why this real threat of chemical weapon use did not become a reality. We can only be glad it happened this way this time.

I believe the strength and true value of the CDTF training is relfected in a statement made by a young soldier, "I thought I might die or be a serious casualty, but I didn't. It (equipment) works!" To have lessened his fear and made him probably less likely to become a psychological casualty, if not an actual casualty, is worth the cost of the training. This carried through to our troops recently involved in the activities in the Persian Gulf. A battalion commander in the 24th ID stated "The major benefit of CDTF training is the degree of confidence which the trainers obtain. Confident trainers will put a sense of purpose in our chemical training (sic)." While a first sergeant wrote "CDTF-Builds confidence in your equipment, and your ability to survive and win in a chemical environment. CDTF is a must in today's world." Perhaps the value of this confidence is best reflected in the following story. A reporter interviewed a soldier who was arriving home from Desert Storm. The reporter asked the soldier, "Were you worried about chemical warfare?" The soldier promptly replied, "Not a bit. We were ready for it." This is the best endorsement of our system that anyone could ask for.

APPENDIX G

Simulant Analysis

APPENDIX G

SIMULANTS

1. General. Simulants for chemical warfare agents are a matter of interest for both the technical (i.e. R&D) and training establishments. To foster international cooperation and to ensure the reproducibility of laboratory results, an International Task Force on simulants and training agents was established in 1987 by MOU between The United States, Canada, and the United Kingdom. The final report of that Task Force was rendered in 1988. Since that date, a series of International Simulant Workshops have been held to update the simulant data base and to coordinate future simulant requirements. A listing of existing simulants is at TAB A.

2. While the data presented in TAB A lists all simulants used in trials (i.e. experiments) and training, it does not address the shortfalls associated with today's training simulants. These shortfalls are identified at TAB B.

3. Shortfalls in simulant utility led to the initiation of a training device requirement for a persistent chemical agent simulant (PCAS) and chemical agent disclosure solution (CADS). The PCAS/CADS system is scheduled to enter full scale development in the first quarter FY93. Fielding of this simulant system will begin in 1996 at the earliest. When fielded, the PCAS/CADS system will simulate persistent agents (vesicant and nerve) by:

a. Physically resembling vesicant/mustard agent--a yellow oily liquid with a garlic odor and thickened nerve agent--a clear, stringy elastomer.

b. Providing appropriate color cues on <u>simulated</u> M8 and M9 paper.

c. Providing positive H and G readings on the CAM and positive G alarm from the M8A1 detector. (NOTE: The chemicals used to provide/provoke these responses are methyl salicilate and diethyl malonate (DEM). These chemical simulants are now under review to determine the environmental and physiological impact of their use.)

d. Revealing completeness of decon with use of a disclosing agent.

4. Shortfalls that will remain after fielding of the PCAS/CADS will be:

a. Lack of a physiological penalty mechanism to provide incentive to maintain mask seals, complete decon, avoid agent transfer etc.

b. Lack of a nonpersistent/semipersistent nerve agent simulant to train commanders and staffs in the art and science of MOPP decision making. MOPP4 degradation, continuing contact/vapor hazard, spread of contamination versus time to decon and lost mission availability are tough trade offs to make.

c. Lack of a realistic simulant for DS2. Existing environmental constraints prohibit the open air use of DS2 in training. We have found our experience with DS2 in the CDTF to be invaluable in terms of improving decon techniques, identifying doctrinal shortfalls, and learning that DS2 vapor causes false CAM readings.

5. Summary. Simulants, like simulators, have a valuable place in today's training environment. Simulants, like simulators, save resources, avoid environmental damage, and allow us to train more soldiers in NBC tasks. The Chemical Corps and the Chemical School have been at the international cutting edge in this area. Nevertheless, at some point the pilot flies, he doesn't simulate; a tanker fires live rounds on tank table VIII, tank table XII, and the CALFEX, he doesn't rely solely on the UCOFT; a soldier in basic training uses the weaponeer, but qualifies in Basic Rifle Marksmanship period 11 with ball ammunition. Chemical Corps soldiers, if they are to "qualify," must detect, identify, and decontaminate live agent, not just simulants. If we are to be your NBC experts, we must do more than just detect and identify simulants with mock detectors. We must do more than simply wash vehicles with water when only a caustic, hard to handle, decontaminant would work against a real agent. We must train as we expect to fight.

INTERNATIONAL TASK FORCE-8
Simulants and Training Agents

Final Report

1. INTRODUCTION

International Task Force-8 (ITF-8), Simulants and Training Agents, was established during the Programme Officers and Requirements Officers (PO/ROs) meeting of 27-29 April 1987, held at the Defence Research Establishment Suffield (DRES), Canada. The objectives of ITF-8 were to:

a. Recommend to the PO/ROs a management (organizational) approach for simulants and training agents.

b. Recommend general directions for subsequent action by The Technical Cooperation Program (TTCP).

The ITF met twice in the United States to complete its objectives. The first meeting was held at the U.S. Army Chemical Research, Development and Engineering Center (CRDEC), Aberdeen Proving Ground, Maryland, from 25 through 28 August 1987. The final meeting took place at the U.S. Army Chemical School (CmlS), Fort McClellan, Alabama, during 29 February through 11 March 1988 and included participation in the Second International Simulants Workshop from 1 to 3 March 1988. The meeting agendas are found at Appendix A with the terms of reference.

The Second International Simulant Workshop was planned and arranged to be held in conjunction with the ITF meeting. This enabled ITF-8 participants to meet before the workshop to develop discussion issues for use at separate working sessions and following the workshop to assess discussions and presentations and to incorporate workshop results in ITF-8 deliberations. More than 71 persons attended the workshop including representatives of the United States, United Kingdom, Canada, Federal Republic of Germany, U.S. Air Force, industry and other U.S. governmental agencies. Technical papers presented at the workshop and a report of findings will be published under separate cover as a CRDEC Special Report. The agenda and list of participants are provided at Appendix B.

2. DEFINITIONS

International and mutual understanding of terminology requires agreement on the lexicon and common spelling of the terms. The North Atlantic Treaty Organization (NATO) glossary of terms was searched for words relevant to the ITF-8 requirements. Very few terms were applicable to the needs of the task force or were considered sufficiently unequivocal for ITF-8 agreement. Where possible, key terms were adopted. The

Ted A. Mack

following set of specific definitions was developed and agreed to for general use by ITF-8. The task force recommends that these terms be given wide distribution and that they be considered as tri-national standard definitions. The PO/ROs should provide these terms to appropriate agencies for consideration in the NATO glossary.

Distinguishing training from trialling is essential and assigning terms peculiar to each is necessary to ensure understanding and for proper distinction during applications. Training is a process of learning whereas trialling is an experiment that is used to obtain quantitative data. Hence,

TRAINING: Process of learning to use equipment or to perform tasks.

TRIALLING: A scientifically designed and evaluated experiment for research, development and testing equipment, procedures and/or performance.

In each instance, material can be used as a substitute for the actual substance. The substance could be chemical or biological (CB) compounds, CB warfare materials, decontaminants, or any other substance. Thus,

SIMULANT: A material that is substituted for a chemical or biological agent or other substance.

In training, the material of use is specific to the process being learned and therefore is considered to be an agent. In trialling, the material of use is selected for a physical-chemical response during the experiment and is considered to be a simulant. As a consequence,

TRAINING AGENT: A simulant used in training.

TRIALLING SIMULANT: A simulant used in trialling.

Other definitions agreed to and of importance are:

INTAKE SIMULANT: A material that is used in trialling or training that may be taken into the body and that can be measured via body fluids.

SIMULATION: Is mimicking CB warfare conditions; e.g., weapons systems, weapons effects, and defensive measures for purposes of assessment, trialling or training.

SIMULATION SYSTEM: Materials, equipment, personnel and procedures used in simulation.

These standard terms have been used throughout the organization and structuring of ITF-8 findings, including categorization, simulants-in-use listing, selection criteria and rationale guidance, and in data base development.

During the review of the NATO glossary, several key definitions were noted that are inconsistent and that should be revised. For example,

CHEMICAL AGENT: A chemical substance that is intended for use in military operations to kill,seriously injure, or incapacitate man through its physiological effects. Excluded from consideration are riot control agents, herbicides, smokes and flames.

BIOLOGICAL AGENT: A microorganism that causes disease in man, plants or animals or causes the deterioration of material.

Considering potential international treaties on banning of chemical warfare weapons, careful deliniation of what is or is not CW/BW agents is needed, especially regarding agents of biological origin (e.g., toxins) and anti-material systems. As an example, with recent developments in biotechnology deliberate deterioration of material (e.g., a chemical agent) by microrganisms could be a useful decontaminant yet be confused as a biological agent. These concerns are not under the perview of ITF-8, but the PO/ROs could make them known to an appropriate agency for consideration.

3. CATEGORIZATION

Simulant applications can be divided into two large categories. Trialling is a scientifically designed experiment to collect data for the purpose of developing equipment, evaluating doctrine, etc. Trialling includes developmental testing, operational testing, as well as basic and applied research.

In contrast, training is a people-oriented exercise in which personnel gain knowledge or learn to perform tasks that may be unfamiliar to them but are established by doctrine. Data collected during training is directed toward grading the students performance and not toward evaluating the equipment or procedures.

Categorization of trialling simulants and training agents by their proposed use, given the agreed upon definitions, is thereby limited to those of:

(1) TRIALLING

(2) TRAINING

(3) OTHER

The two major categories, trialling and training, incorporate the vast majority of use of substitute materials. A few simulant applications do not fall into either category. For example, a demonstration performed to illustrate equipment or principles. The demonstration would not be training because the purpose was not to teach the audience to perform a task. It would not be classified as trialling because no data would be collected. Mask fit checks are another example of the "other" category of use.

Each major category of use has associated with it, one or more sub-categories. The sub-categories were developed through consideration of the TTCP Technical Panel-8, Survivability and Sustainability, deliberations on hazards management. Although not included here because the emphasis is on chemical defense, an additional sub-category for retaliatory munition systems could be generated. The elements considered under each sub-category are examples of use and readily expanded. The sub-categories with examples are also shown in figure 1.

(1) Threat/Hazard

Dissemination/Mechanisms

(2) Individual Protection

Eye·respiratory
Body

(3) Collective Protection

Entry/Exit
Air Purification

(4) Decontamination

Physical
Chemical

(5) Material Protection

Covers
Hardening

(6) Medical

Prophylaxis
Therapy

(7) Detection

SUBCATEGORIES OF USE

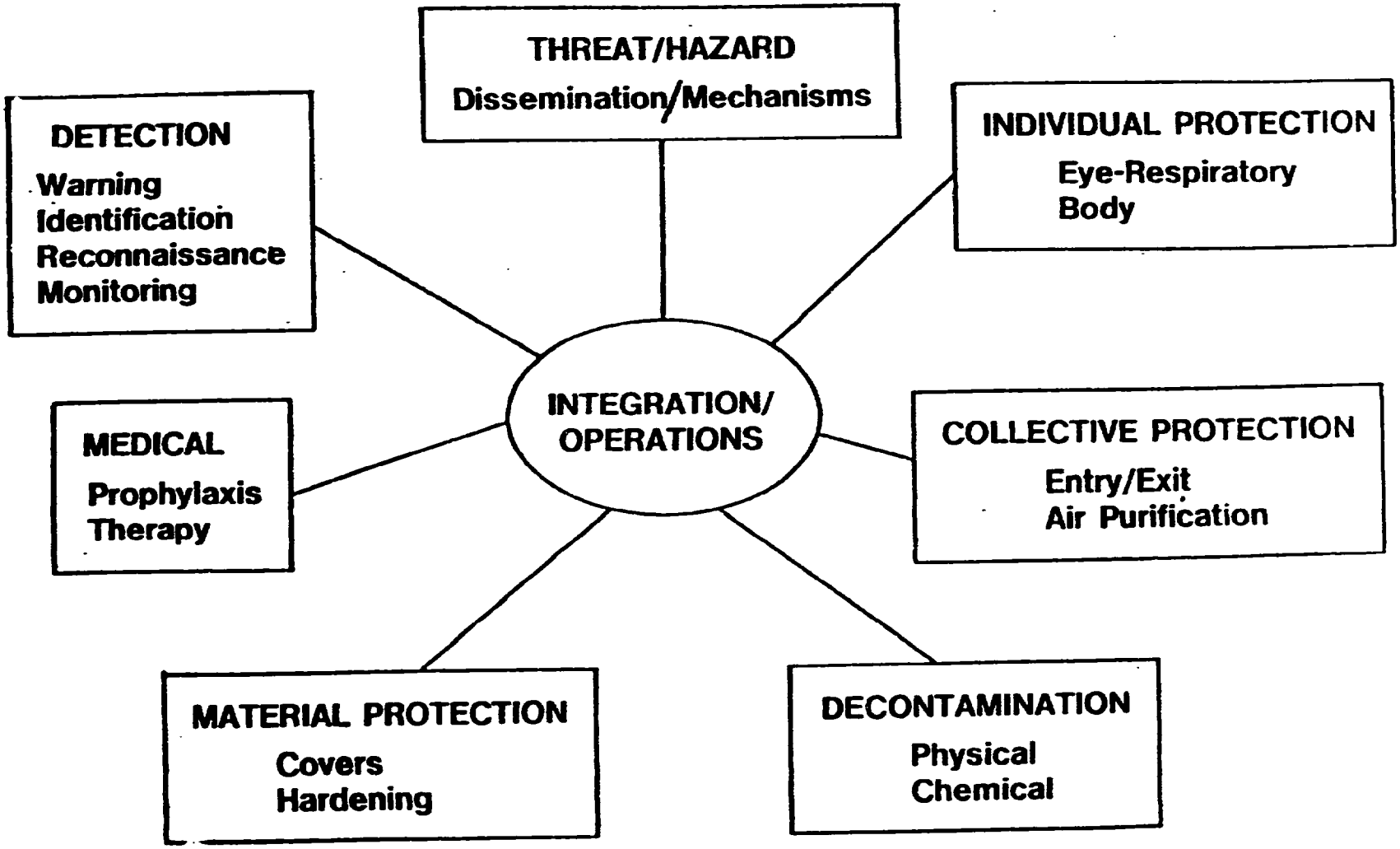


Figure 1. Subcategories of Use

Warning
Identification
Reconnaissance
Monitoring

(8) Integration/Operations

When one material is used for multiple purposes, for example, in a test involving terrain contamination, evaporation from surface contamination pickup by traversing personnel and activation of detectors, the sub-category of integration/operations applies. Too frequently, a single material is used for too many diverse purposes and the results can be misleading, inconsistent and incorrect. Because simulants mimic properties of agents, there are no universal simulants. A compound or mixture may be an ideal simulant for one application and worthless for another.

Proper selection of the trialling simulant or training agent is essential. The selection of a simulant is a rational process which depends on the intended use of application. Criteria that need to be considered when selecting simulants for trialling or training agents are discussed in the next section.

4. SELECTION CRITERIA

The selection process and acceptance of a trialling simulant or training agent requires various data sets and decision networks to be constructed. ITF-8 established guidelines on those information sets that are needed to support the choice of a simulant for a given trial or training exercise. Each element should be addressed in any subsequent technical report where trialling simulants or training agents are used. The extent of data and information and its order of importance can be substantially different between a trialling simulant and a training agent because their intended uses differ. The order of importance of the items are scenario of use dependent, except for a training agent, where the medical/safety and environmental impact items are paramount.

Protocols of use should include the following data-informational items:

(1) A clear statement of intended use or purpose
(2) Medical/safety
(3) Environmental impact
(4) Chemical-physical properties
(5) Analysis
(6) Sampling
(7) Application/dissemination
(8) Precedents
(9) Agent/simulant correlations
(10) Estimation methods

(11) Producibility
(12) Disposal
(13) Storage
(14) Stability
(15) Material compatibility

Some specific details regarding these elements follow and differences in guidelines between trialling simulants and training agents are indicated.

(1) A clear statement of intended use or purpose: This is of utmost importance in proper simulant selection. The operational conditions controlling the physical-chemical properties during the experiment or training event must be appropriate for the intended purpose. This statement is crucial to the selection process and must remain in focus at all times.

(2) Medical/safety: includes toxicology data. The required data will depend on the user country and the intended use of the material. General guidelines of supporting data elements useful in assembling adequate information to obtain medical approval of use is attached at Appendix C. [CDE Technical Note No. 673, Gall, D., "Guidelines for the Assembly and Presentation of Toxicological Data," Dec 1984.]

(3) Environmental impact: includes the effects of the chemical on flora, fauna, and microbial systems. Criteria depends on particular country and will change as new regulations are introduced. This element is becoming extremely important as environmental laws and regulations become more restrictive. Typical information elements needed in planning for an environmental assessment are illustrated in Appendix D.

(4) Chemical-physical properties: principally those essential properties necessary to mimic the agent in the intended application.

(5) Method of analysis: includes method for sample collection, preparation, separation and quantification.

(6) Application/dissemination: includes methods for applying known amount of simulant, in a reproducable and predetermined manner.

(7) Precedents: previous uses - simplifies comparisons with earlier experiments.

(8) Agent/simulant correlations: includes results of studies such as penetration through materials, dissemination parameters, etc., that are difficult to describe and predict from physical properties. Simulant material is frequently used to develop trialling procedures, test methods and to conduct "dry" runs before an actual agent is used.

Technical reports need to incorporate any simulant data acquired to enable correlations to be drawn with agent data/results.

(9) Producibility/cost: includes consideration on general availability of material. A large increase in demand could increase or reduce cost.

(10) Disposal: includes responsible methods for disposal as well as estimates of cost. This criterion would be minimal if all the simulant is consumed and no products are produced.

(11) Stability: includes stability of chemicals and their containers. If containers are likely to leak, additional consideration for disposal must be included. If the simulant is stable for only a few hours, then there will be additional producibility considerations involving preparation immediately before use.

(12) Material compatibility: includes effects of simulants on clothing, rubber, plastics, electronics, etc. - anything the simulant or vapor could contact during normal operations or accidental exposures.

TRIALLING:

In a trialling study, matching the essential chemical-physical properties is the initial consideration because the entire study depends on that correlation. Methods for analysis are also important because collecting data is the essential requirement in a trialling study. If the physical and chemical properties have been properly selected, there will probably be good compatibility between the simulant and the item to be tested.

The medical/safety issues and environmental imput will effect how the study is performed. It may be possible to minimize safety and environmental problems by using extra protective equipment and performing the studies in a controlled environment. If the study must be conducted outdoors with minimally trained personnel, then unacceptable medical or environmental impacts would preclude approval of the simulants.

The methods for disseminating the simulant usually depend on the protocol. Only in unusual circumstances would a simulant be rejected because of dissemination difficulties. Although comparisons with previous data have value, the selection of a simulant because it was used previously should be discouraged. The objective purpose statement must be kept in mind at all times.

Because the duration of a trialling study is relatively short and the quantity of simulant limited, the following criteria usually have minimal impact:

(1) producibility/cost
(2) disposal
(3) storage
(4) stability

TRAINING:

For training applications, the medical/safety and environmental impact criteria are the most important. Adverse effects with either criteria precludes use of the compound for training except under unusual conditions in enclosed environments such as the Chemical Defense Training Facility (CDTF) at Fort McClellan, AL. The following criteria are significant, but their impact could be overcome if other criteria were met:

(1) producibility/cost
(2) disposal
(3) storage
(4) stability
(5) material compatibility

Except in unusual applications, the following criteria have minimal contributions to the selection of training agents:

(1) chemical and physical properties
(2) methods for analysis
(3) methods for application and dissemination
(4) precedents
(5) agent/simulant relationships

Training and trialling exercises have different purposes. Although the same considerations apply when selecting trialling simulants and training agents, the priority for each criteria differs widely.

5. MATERIALS IN USE

Each country provided a list of trialling simulants and training agents used within the past 5 years or planned for use in the next 5 years. The lists were consolidated according to the agreed terminology, categorization, and sub-categorization discussed earlier.

The combined lists are shown in Table 1. The compound name, Chemical Abstracts Service registry number and agreed to abbreviation identify the material and are for general purpose use. The chemical or biological agent for which the compound has been frequently substituted is shown but no claim for good correlation with properties or behavior is made or intended. A column is devoted to which countries use the compound and whether the material has also been used in a thickened state, noted under the * column by a "T" symbol. An X in a column block below the corresponding category of use indicates the specific sub-category for

LE I

SIMULANTS IN COMMON USE

1. CANADA

2. UNITED KINGDOM

3. UNITED STATES

CODE For TRAINING/TRIALLING COLUMNS

* Thickened

1. Threat/Hazard
2. Individual Protection
3. Collective Protection
4. Decontamination
5. Material Protection
6. Medical
7. Detection
8. Integration/Operations (OT/DT)

X = Used currently or during last 5 years

P = Planned

SIMULANTS

COMPOUND	REGISTRY	ABBREVIATION	AGENT	COUNTRY		TRIALLING								TRAINING								OTHER	
					*	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8		
Methyl salicylate	119-36-8	MS	H	CA	T	X	X	X	X			X	X							X		FOR USE W/CAM	
				UK	T	X	X		X		X	X	X							X			
				USA	T	X	X	X	X	X		X	X							X			
Propyleneglycol monomethyl ether	34590-94-8	DPM	GD or persistent agent	CA								X								X		FOR USE W/CAM	
				UK	T						X	X								X			
				USA								P								X			
Diethyl malonate	105-53-3	DEM	GD	CA	T	X																	
				UK	T						X												
				USA	T	X	X	X	X	X		X	X										
Triethyl phosphate	78-40-0	TEP	GD and vapor tracer	CA	T	X		X	X				X										
				UK	T			X					X										
				USA	T					X													
Dimethyl sulfoxide	67-68-5	DMSO	GD or persistent agent	CA	T	X	X	X	X				X										
				UK				P															
				USA																			
Dimethyl methylphosphonate	756-79-6	DMMP	GB; GD	CA	T	X																	
				UK	T	X						X											
				USA	T	X	X	X	X	X		X	X										
Chlorobenzylidene-malonotrile	2698-41-1	CS	vapor	CA		X									X	X	X					X	X
				UK										X	X	X				X		X	
				USA										X						X		X	
Polyethylene glycol 300	25322-68-3	PEG 300	HD or persistent agent	CA																			
				UK	T									X	X				X	X			
				USA																			
Polyethylene glycol 200	25322-68-3	PEG 200	HD or persistent agent	CA																			
				UK																			
				USA	T	X	X		X			X	X			X				X			
Methyl acetoacetate	105-45-3	MAA	GB	CA																			
				UK									X										
				USA		X							X										
Tributyl phosphate	126-73-8	TBP	VX	CA	T	X						X	X										
				UK	T		P						X										
				USA				X		X													
iso-Amyl acetate	123-92-2	-	vapor tracer	CA																		mask fit	
				UK																		mask fit	
				USA			X															mask fit	

Sodium chloride	7647-14-5	NaCl	particulate	CA			X															
				UK			X															
				USA			X															
Corn oil		-	particulate	CA			X															
				UK																		
				USA			X															
Sulfur hexafluoride	2551-62-4	SF_6	vapor tracer	CA		P																
				UK			P															
				USA				X				X										
Bacillus subtilis		BG	spore former	CA		X	X	X				X	X									
				UK																		
				USA		X	X	X				X	X									
Erwinia herbicola			Vegetative bacteria	CA		P	P	P				P	P				P					
				UK																		
				USA			P	P				P										
Newcastle disease virus (vaccine)		NDV	virus	CA		P		P									P					
				UK																		
				USA			P	P				P										
n-Butyl mercaptan	109-79-5	BUSH	vapor	USA			X							X								no longer used/authorized
bis-(2-ethylhexyl) phosphonate	3658-48-8	BIS	VX	USA	T	X			X				X									
bis-(2-ethylhexyl) 2-ethylhexylphosphonate	126-63-6	-	VX	USA	T				X													
Diisopropyl fluorophosphate	55-91-4	DFP	G	USA		X			X	X	X	X										
Diisopropyl methylphosphonate	1445-75-6	DIMP	G	USA						X												
1,5-Dichloropentane	628-76-2	DCP	H	USA					X	X												
Diethyl adipate	141-28-6	-	G	USA					X													
Tetrachloroethylene	127-18-4	TCE PERC	H	USA						X												
bis-(2-ethylhexyl) phthalate	117-81-7	DOP	smoke particulate	USA			X															
Chloroethyl ethyl sulfide	693-07-2	CEES	H	USA		X			X	X												
1,2,3- Trichloropropane	96-18-4	TCP	CB	USA		X						X										
Methyl anthranilate	134-20-3	MA	HD	USA					X			X										
Triethyl phosphite	122-52-1	TEPh	VX	USA	T	X						X										

[illegible]thyl anthranilate	134-20-3	MA	HD									X										
[illegible]									X			X										
[illegible]	[illegible]	TEPh	VX		T	X						X										
Triisopropyl phosphite	116-17-6	TIP	VX	USA	T	X						X										
Tri(2-ethylhexyl) phosphate	78-42-2	TOF	VX	USA	T	X						X										
Stannic chloride	7646-78-8	$SnCl_4$	vapor	USA																		mask check
Zinc Sulfide	1314-98-3	FP	vapor/aerosol	USA		X	X	X	X	X		X	X									
1,4-Dibenz[b,f]oxazepine		CR	persistent	CA											X							
TEP + 0.1% Tinopal SWN			GD	CA		X		X									X					
0.75% Sodium carbonate in propylene glycol/water			persistent	CA													X			X		
Kerosene and liquid parafin			H	UK									X									
Kerosene thickened with polyisobutylene			H	UK	T								X									
Chloroacetophenone	532-27-4	CN		UK																		mask fit
p-Toluenesulfonyl chloride	98-59-9			UK																		test of SICS
Dichlorvos	62-723-7	DDVP	nerve agent	UK																		Demonstration of NAIAD
Chlorobenzene	108-90-7		GB	UK																		Large scale filter testing
Ethanol	64-17-5	EtOH	vapor tracer	UK				X														

which that compound is used currently or within the previous 5 years. A "P" code indicates that the country plans to use the compound for the specific subcategory of use in trialling or training in the next 5 years.

The table reveals in an abundently clear manner that a universally acceptable compound for trialling and training is not available. Methyl Salicylate has had some dual purpose use but in general the requisite characteristics for a trialling simulant differ from those necessary for training agents. There is no substitute for the actual agent and dual-purpose materials, although desireable, will be exceptionally difficult to synthesize.

The table points out substantial gaps in the sub-categories of use for training agents and the number of compounds used in training. Further, more compounds have been used as trialling simulants than materials used as training agents. The compounds are not interchangeable and the rationale and criteria for acceptance must be examined closely for proper compound selection.

Human use protocols, involving safety and toxicity, and environmental concerns are becoming more and more restrictive, thereby limiting even further, the suitability of compounds. The day of conducting field trials without constraints is over. The time and expense involved in synthesis of new materials specific for trialling or training and in acquiring sufficient toxicity, environmental fate and safety data with which to obtain approval for open air and human use are expected to become prohibitive. Greater emphasis and efficiency is needed in surveying and assessing potential use of new compounds created by industry.

One compound used extensively by all three countries in trialling and training is Methyl Salicylate. The U.S. has undertaken an independent task to prepare an authoritative source book on Methyl Salicylate in operational testing and the data entries and discussion will make use of the selection criteria guidelines presented in Section 4.0.

The lists of compounds in use need to be periodically updated preferably through established points of contact in each country. Initially, ITF-8 members visualized this being done concurrent with the updating of the proposed simulants data base (see Section 7.0).

The use of trialling simulants in medical chemical defense research is not well documented or in many cases, not warranted; however, the need for training agents for use in therapy, prophylaxis, decontamination and medical management of chemical casualties appears strong. A more comprehensive examination of requirements for trialling simulants and training agents should be performed. The same examination is needed for assessing the requirements in biological defense.

6. TRAINING DEVICES/REQUIREMENTS

Training device requirements and needs are in the process of development and are undergoing rapid changes. Close coordination and collaboration needs to be developed between persons responsible for specifying and preparing training agents and those for trialling simulants. The CRDEC is not currently engaged in developing training agents for the U.S. Army since this function is performed by the Project Manager, Training Devices (PM-TRADE).

An overview of training devices and simulations, prepared by the U.S. Army Chemical School, is provided at Appendix E. Basic goals and operational tasks and mission statements for nuclear operations, biological operations and for chemical operations are included therein. Appendix F is the most recent edition of the training device requirement for a Persistent Chemical Agent Simulant (PCAS)/Chemical Agent Disclosure Solution (CADS). A major effort is needed to develop and field training devices. Brief descriptions of the following training agents and devices are contained in Appendix G:

a. MII-SPAL: Simulant, Projectile, Airburst Liquid

b. M256-TRAINS: Simulator, Detector, Chemical Agent; Training

c. M81: Simulator, Detector Unit, Chemical Agent Automatic Alarm

d. M272E1: Water Testing Kit, Chemical Agents

e. USAF Intake Simulant: Chloropentafluorobenzene

f. US Navy Chemical Agent Simulant and Helicopter - Mounted Disperser

g. PCAS: Persistent Chemical Agent Simulant

The UK list of needs for training agents and table of training agents used at the individual and sub-unit level are contained in Appendix H.

Quadripartite Standardization Agreement (QSTAG) 756 describes the current designs, specifications and other information regarding the US Simulant Chemical Agent Identification Training Set, M72A2 (SCAITS), the British Residual Vapour Detector, Tactical Training Aid, No. 1, MK1; and the Canadian Training Kit, Chemical Warfare Agent Detection, Liquid and Vapour. QSTAG 832, Chemical Defense Trialling Simulants, contains information on Methyl Salicylate which is the only US/UK agreed upon trialling simulant. These QSTAGs are contained in Appendix I. QSTAG 833, Chemical Defense Training Agents, currently undergoing changes to

SIMULANT SHORTFALLS

1. Simulants allow limited practice of chemical warfare techniques and procedures. No one simulant replicates the battlefield effects of chemical agents on humans, detectors, alarms, or decontaminants. Lacking a multispectrum/multipurpose simulant, we are reduced to single event, single purpose simulants that do not realistically challenge our NBC defense procedures. A brief synopsis of simulant-system combinations is as follows:

Simulant	System Interaction	Shortfall
CS powder/capsules	Mask confidence/punishment for improper seal	Does not activate detectors/alarms. Does not "decon" similar to liquid agent. Powdered CS not intuitively as penetrating as nerve/mustard "vapors."
Polyethylene glycol (PEG 200)	Reacts with M8 paper simulating liquid contamination	No vapor challenge to masks or M256 kit, M8A1 alarm, chemical agent monitor. Delayed reaction with M8 paper (20-25 minutes). No reaction with M9 paper.
TALC	Used as a substitute for STB in dry decon mix	Talc is inert. No reaction occurs between simulant agent and simulant decontaminant.
Water	Substitute for DS2 in basic soldier skills decon and in deliberate equipment decon	Does not react with simulant agents. Does not coat/gel like DS2--wrong consistency. Not caustic. Does not interfere with CAM, M8A1.

T, D, A, G

APPENDIX H

Desert Shield/Storm Lessons Learned

DEPARTMENT OF THE ARMY
US ARMY CHEMICAL SCHOOL
FORT MCCLELLAN, ALABAMA 36205-5020

REPLY TO
ATTENTION OF

ATZN-CM-Z

10 June 1991

MEMORANDUM FOR RECORD

SUBJECT: Emerging Insights on Chemical Defense from Operation Desert Shield/Storm: Usefulness of Real-Agent Training.

1. Some have questioned the effectiveness of our Chemical Decontamination Training Facility (CDTF) since only a small percentage of the Army has the opportunity to undergo such training. A review of interviews with soldiers both in and returning from the Gulf provided a counterpoint.

2. For the first time since World War I, American Soldiers truly believed they were about to face the spectre of gas warfare. According to one Major,

> "The lack of NBC knowledge coupled with the ever present chemical threat, caused a fear of the unknown. Numerous unit commanders, primarily company grade, thought their first response to a chemical attack would be to vacate the area. I spent many a hour calming fears and reminding commanders their first responsibility was the accomplishment of their respective mission."

How did our soldiers master their fear? According to a chemical staff officer, the chemical infrastructure at company level was key. A number of new items, e.g., M291 skin decon kits, nerve agent pretreatment tablets, etc., were successfully introduced because of the expertise of these chemical soldiers. Many problems with protective clothing were overcome because these soldiers could point out that they had actually worn the gear in a toxic environment, i.e., the CDTF. The staff officer also stated that, in addition to payoffs in confidence and credibility, CDTF graduates also had a better understanding of the technical difficulties of decontamination and detection, e.g., the problems of persistent nerve agent vapor detection due to its low volatility. Several noncommissioned officers cited the proficiency and motivation of the unit's 54BS (chemical NCO's) to teach others and prepare the unit for operating on a contaminated battlefield.

3. An Army Lessons Learned Team interviewed over 300 personnel from Private through Lieutenant General on a non-attribution basis. A member of that team reported the following:

a. Chemical soldiers trained at the CDTF universally demonstrated complete confidence in the chemical defense equipment (CDE). All chemical command and staff personnel stated that the training they received at CDTF proved their chemical equipment would protect them on the NBC battlefield.

b. Non-chemical soldiers lacked confidence in their protective equipment. Although they felt their training was adequate, they were unsure that their equipment would fully protect them in a chemical environment. Correct mask fit, serviceability of CDE, and effectiveness of the decontamination kit were prime concerns.

c. Operationally, the lack of live agent experience resulted in much lower soldier confidence levels. Many soldiers actually ruined their masks due to anxiety over correct fit. Frequently, they overtightened their masks until the buckles ripped out of the faceblank.

d. CDTF trained chemical cadre were able to offset this lack of confidence by sharing their live agent training experience with unit members. CDTF qualified chemical personnel possessed credibility, giving soldiers tangible proof that CDE would protect the force.

4. A reserve component battalion commander, who trained at the CDTF prior to departure, said,

> "Having experienced the threat of chemical warfare first hand, I am convinced that the psychological fear of the unknown is the most pervasive aspect of chemical warfare. Our training experience at the CDTF helped us overcome that fear. The confidence inspired by this "hands on" experience is truly underestimated. Specifically because of our "experience" we were often asked to provide advice and instruct other units. Confidence is contagious."

5. While there is no absolute answer as to why Iraq failed to use its chemical weapons, one division commander cited the Iraqi belief that the U.S. had a robust chemical defense capability that would allow us to continue combat operations in a chemical environment. As a bottom line, this combat hero stated that the, "U.S. must maintain and improve defensive chemical warfare capabilities." While deterrence worked, the future reliance on treaties instead of an offensive chemical capability, will place even more emphasis on NBC defense. The pillars of contamination avoidance, protection and decontamination cannot become a real experience without the psychological aspect which mandates training in a toxic agent environment. Denying a chemical soldier the experience of facing an actual chemical agent is akin to denying the airborne soldier the opportunity to actually jump out of an aircraft.

Robert D. Orton

ROBERT D. ORTON
Brigadier General, USA
Commandant

DEPARTMENT OF THE ARMY
HEADQUARTERS, 490th CHEMICAL BATTALION
3415 McCLELLAN BOULEVARD
ANNISTON, ALABAMA 36201-2198

17 May 1991

Brigadier General Robert D. Orton
Commandant
USACMLS
Fort McClellan, Alabama 36205-5000

Dear General Orton:

On behalf of the 490th Chemical Battalion I would like to express our appreciation for your support during our deployment and redeployment for Operation Desert Shield and Desert Storm.

Your extraordinary efforts to provide us with the most current information prior to deployment were invaluable. The information you provided about the Iraqi chemical threat and the defensive capabilities of coalition forces allowed us to make significant contributions as soon as we arrived in theater. Because of the special relationship between the 490th Cml Bn and the Chemical School our counsel was frequently sought. The challenge was immense. Your assistance helped us to succeed.

I would like to make special mention of the training you provided at the Chemical Decontamination Training Facility (CDTF). Having experienced the threat of Chemical warfare first hand, I am convinced that the psychological fear of the unknown is the most pervasive aspect of chemical warfare. Our training experience at the CDTF helped us overcome that fear. The confidence inspired by this 'hands on' experience is truly underestimated. In addition, the 490th Cml Bn's experience at the CDTF influenced more troops than you might imagine. Specifically because of our 'experience' we were often asked to provide advice and instruct other units. Confidence is contagious!

The 490th Cml Bn is proud to be a member of the Chemical Corps. Please accept our sincere thanks for your support of the 490th Cml Bn and your outstanding work for the Corps.

Sincerely,

Evis R. Thompson

Evis R. Thompson
LTC, CM
Commanding

APPENDIX I

CDTF Lessons Learned

APPENDIX I

CDTF Lessons Learned

1. The Chemical School identified significant "lessons learned" through training conducted in the CDTF. These lessons are an additional benefit provided by five years of training in a chemically contaminated environment using our current protection, detection, and decontamination equipment and our current doctrine. The CDTF is the only location where soldiers can train as they would fight. When soldiers repeatedly put their equipment through the rigors of live agent training, the strengths and weaknesses of equipment and doctrine are noted and passed from instructor to student. The lessons learned here are sent to: doctrine writers, combat developers, and, in message form, to the rest of the Army. These lessons provide essential insights into the effectiveness of our doctrine and our equipment.

2. Specific lessons learned are identified in this and subsequent paragraphs. They are grouped under the three fundamentals of NBC defense: contamination avoidance, protection, and decontamination. Specific lessons learned relevant to contamination avoidance are:

a. M9 Chemical Agent Detector paper.

1. DS2 will make M9 paper almost impossible to remove if DS2 is sprayed over it. M9 paper must be removed prior to spraydown with an M11/M13.

2. GB and VX contamination show up as different shades of red on M9 paper. GB is a shade lighter than VX.

3. DS2 shows up as a black color.

b. M8 Chemical Agent Detector paper.

1. DS2 mimics a positive test for a V series nerve agent.

2. M8 paper does not decontaminate agent when it changes color. Students often spread agent through improper handling of contaminated M8 paper. They either don't realize the transfer hazard involved or they think the paper somehow neutralizes the agent when the paper detects it.

c. M256 Chemical Agent Detector Kit

1. The protective strip is not designed to be used as a handle when waving the M256 Kit around. When your protective gloves are wet, the handle will fall apart.

2. Heater tabs are needed to crush the ampules. If heater pads are not used to safeguard the protective gloves, the gloves can be punctured by broken glass. If the tabs are lost, a soldier could use the foil package.

3. For the M256 Kit, red light allows the soldier to identify a "safe" reading. However, soldiers employing the M256A1 Kit need white light to identify a "safe" reading.

4. If you want to confirm liquid VX when M8/M9 paper indicates a positive response, use a stick or swab to transfer agent to the M256 Kit nerve test spot. If it is VX, you will get a positive response. Liquid bleach also gives a positive response for nerve agent presence. DS2 will give a purple color.

d. M8A1 Alarm.

1. The charcoal plug of the flowmeter will filter out chemical agents. This could give a false negative reading if the flowmeter was left on the detector. This can also be used as a method of resetting the detector in a contaminated area. It allows periodic monitoring with the M8A1 (in lieu of using the M256 Kit) until the chemical agent concentration dissipates below the M8A1 threshold.

2. DS2 vapor will trigger the detector and cause a false alarm.

3. Extended usage shows excellent reliability. Most lasted about two years, running continuously (24 hours/day, 7 days/week), and had only a few false positive responses during that period.

e. M272 Water Test Kit. It does not work on our waste water, apparently due to the high bleach content. This has an application in the testing of runoff from decontamination lines.

f. Chemical Agent Monitor (CAM).

1. It takes 20-30 seconds to detect low concentrations of agent. During this time, the CAM must be held downwind from the suspected point of contamination.

2. The battery life is short, typically 10 hours or less of operation. Additional batteries must be available if the CAM's use will exceed 10 hours.

3. Standoff filters must be replaced often because they tend to become saturated with agent vapor quickly.

4. The protective cap must be on during start-up or a bad calibration will result. During start-up, the protective cap filters the air and provides a clean reference point.

5. If the protective cap gets wet, it must be replaced.

g. Art of vapor sampling. Many students, from new soldiers to veteran chemical specialists, do not realize that chemical agent vapors travel with the air currents and wind. This is especially evident with the use of the chemical agent monitor. The vapor must be captured downwind of the point source to be detected. This is true with any of the vapor detectors in the inventory. A critical problem is to determine air currents in almost still air or light wind. We use stannic chloride smoke to help illustrate the air movement inside the training bays. With this information, we identified a doctrinal weakness. There are no identified methods to determine air movement while in MOPP IV.

3. Protection.

a. M17A2 Protective Mask.

1. This type of protective mask experiences 72% turnover annually due primarily to torn button holes. The majority of the button holes are torn when the filters are changed by personnel in MOPP IV. In one year, each protective mask goes through approximately 120 CDTF mask filter changes, about 10/month. This information allows us to estimate protective mask attrition when nonchemical soldiers change their filters as part of deliberate troop decontamination.

2. Long contact (several hours) with bleach will discolor the face blank but will not affect the performance of the mask.

3. Some inlet valve caps do not seal on the filter neck causing apparent leaks on the seal test. The solution is to remove the cap then check the fit.

4. Repeated decontamination of the protective mask hood often results in draw string failure. The leather slide breaks because of dry rot/decomposition. The M40 protective mask will use a plastic slide to avoid this problem.

5. Many students tighten the head harness too tight and develop hot spots or headaches. In non-agent trials, 1 student per 87 had problems. When agent was used, this increased to 1 student per 14 with headache problems. This reinforces the claim that the psychological effect of agent presence causes students to doubt themselves and their equipment unnecessarily. Training in a live agent environment builds confidence and reduces this problem.

6. Some buckles for the head harness are steel. They rust after decontamination.

7. During personnel decontamination operations, it is better to roll the protective mask hood from top to bottom. This

gives a tighter fit. It is also opposite the doctrinal method.

8. The use of banana oil confirmed the effectiveness of mask fit procedures. However the Technical Manual (TM) does not address a five minute wait if the student smells banana oil. This is required by the OSHA standard to restore "odor sensitivity". It is also common sense because the banana oil smell is powerful and lingers even after the soldier leaves the area.

b. M40 Protective Mask.

1. C2 filters cannot be changed in a contaminated environment.

2. The hood slide is plastic. It should be more durable for decontamination.

c. Battle Dress Overgarment (BDO).

1. The newer version has more loose charcoal than the older version. According to preventive medicine personnel, the charcoal dust is not a health hazard.

2. The BDO is generally water repellant and DS2 resistant. It is very durable, but soldiers feel it retains more heat than the Chemical Protective Overgarment (CPOG).

3. The velcro wrist tabs are too long resulting in a potential contamination transfer hazard. We cut them off after tightening the BDO.

4. Mission Oriented Protective Posture (MOPP) gear exchange procedures do not compromise soldier safety in a vapor contaminated environment.

d. Gloves.

1. Soldiers usually need gloves one size smaller than what they normally wear. This aids tactile sensitivity.

2. Oil based products, like DS2, Break Free, and Antiseize Compound, attack the rubber. Bleach is moderately successful in removing these compounds from the gloves.

3. The gloves are easily torn and punctured by the M11 and M13 decontamination devices and the M256 Kit, unless protective precautions are taken.

e. Overboots.

1. Bleach/High Test Hypochlorite (HTH)/Super Tropical Bleach (STB) will cause a quick failure of the drawstrings due to decomposition of the cotton.

2. The overboot rubber is very durable.

4. Decontamination.

a. M258A1.

1. Each set of packets (#1 and #2) will only decontaminate 2-3 microliters of VX. The Lethal Dose where 50% of our soldiers become casualties (LD50) is 10 microliters. Most of the decontamination is physical removal of the agent.

2. Packet #1 decontaminates agents GB and H, packet #2 decontaminates agents VX and H. Both packets must be used to avoid chemical burns.

3. We found several inflated or bloated #2 packets. We then sent out a DA message to inspect stocks of the M258A1 and segregate deficient packets.

4. The packets, regardless of sequence of use, leave a residue. We use a towel to wipe off the residue after it dries.

5. This residue produces a color change on M8 paper similar to a positive response for GB.

b. M11.

1. The sprayhead gums up and becomes inoperative after a few uses with DS2. The life of the nozzle can be extended using a bleach cleaning solution. Once a week, we fill the M11 with bleach, charge the device and spray out the bleach. We then repeat the process with water.

2. We use silicon lube (instead of antiseize compound) on the threads of the M11 and its spray nozzle. The antiseize compound attacks the rubber gloves and it is difficult to apply. Silicon lube comes in a tube, it is easier to apply, and it affects the rubber gloves to a lesser degree.

3. We developed a safety shield to prevent the nitrogen cylinder from shooting out of the M11 when it was charging the device.

c. M13 Decontamination Apparatus (DAP).

1. Do not lube the pump assembly with petroleum based products like WD40. This causes the inner preformed packings (O-rings) to swell and break. Use silicon spray IAW the TM.

2. A soldier can pump DS2 from a 5 gallon can if the hose is submerged in the can.

3. Use bleach to remove residual DS2 when cleaning the M13 after use. Specifically, wash with bleach and rinse with water.

4. Use silicon spray on hose quick disconnects to extend their life.

d. Deliberate Decontamination. Deliberate troop decontamination is addressed in numbers 1-3, while detailed equipment decontamination is addressed in numbers 4-7.

1. Use a bath cloth and bleach to remove residue of M258A1/M280 from the eye lens of protective masks.

2. Hold the voicemitter when rolling the hood or you will break the seal of the mask.

3. Have a decontaminant available at the liquid contamination control line to decontaminate combat boots that accidentally touch the liquid contamination side.

4. Do not apply DS2 with a mop, a mop will not hold enough DS2.

5. Pour DS2 from a 5 gallon can onto flat horizontal surfaces then spread the DS2 with a broom. This will effectively decontaminate the flat surfaces. In order to decontaminate crevices and vertical surfaces, use the M11/M13.

6. It is difficult to maintain traction on a DS2 covered vehicle. Use a safety spotter to reduce the danger of injury.

7. We confirmed the effectiveness of decontamination procedures using DS2 on a Chemical Agent Resistant Coating (CARC) type paint.

e. Decontamination Solution #2 (DS2).

1. It thickens within 30 minutes and is difficult to remove.

2. It gels within 24-48 hours.

3. It activates the M8A1.

f. Corrosion. It is a major problem, given the corrosive nature of DS2. Equipment repeatedly exposed to DS2 requires more frequent lubrication than normal.

5. The CDTF will continue to provide "lessons learned" that can be disseminated to the rest of the Army. As doctrine changes and new equipment is fielded, the CDTF will provide the United States with the only means, short of war, to train as we fight using our newest equipment and following our doctrine.

APPENDIX J

CDTF Student Population

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CDTF Student Population

1. We utilized the CDTF to train almost 20,000 soldiers and civilians from around the world. These personnel come from a wide variety of positions and assignments to experience the live agent training offered only in the CDTF. Information on each course and its student load is presented in the rest of this appendix. The information is organized by course. A brief explanation on the course is given, followed by the number of classes and students trained.

2. Chemical Defense Training Facility - Training as of 16 Dec 91.

		TOTAL TRAINED TO DATE	
COURSE	PARTICIPANTS AND FOCUS	CLASSES	STUDENT
COAC	The Chemical Officer Advanced Course is attended by active, reserve, and national guard officers. These senior 1LTs and junior CPTs typically attend COAC following 3 or more years of service. Allied officers also attend COAC.	26	443
COBC	The Chemical Officer Basic Course is attended by active, reserve, and national guard officers. This it typically the first active duty military experience for these officers. Allied officers also attend COBC.	48	1677
ANCOC	The Advanced Noncommissioned Officer Course is attended primarily by active component senior Staff Sergeants. It provides the last MOS specific training these NCOs will get in the Army.	36	1154
BNCOC-R	This Basic Noncommissioned Officer Course is for Sergeants reclassified as chemical specialists (54Bs). Following BNCOC-R, these NCOs will typically perform their first chemical assignment, at the company level throughout the Army.	32	832
BNCOC	This course is primarily for Chemical SGTs. Following BNCOC, these NCOs will typically be assigned at the company level throughout the Army.	59	1493

COURSE	PARTICIPANTS AND FOCUS	CLASSES	STUDENT
OSUT	One Station Unit Training is for newly enlisted soldiers. The soldiers go through Basic Training first, then they receive NBC specific training and are classified as 54Bs.	58	2332
SCC/PCC	The Senior Commander's Course/Pre-Command Course are two courses for senior leadership in the Army. The SCC is for non-chemical personnel, while the PCC is for chemical officers who are preparing to take command.	9	416
TEC/EOD	The Technical Escort and Explosive Ordnance Disposal personnel attend training at the CDTF. Both types of personnel require the ability to function in a contaminated environment.	50	714
USN	The United States Navy trains junior navy seamen in Chemical, Biological and Radiological (CBR) defense. Seamen practise their skills first in an agent-free, and later in a live agent environment.	42	833
RESERVES	This training is for Army Reserve Officer and Enlisted soldiers. They perform the same type of duties as their active duty counterparts.	15	596
USMC	This course is for United States Marine Corps Enlisted soldiers. Live agent training is part of their curriculum. Marine officers and warrant officers train as part of COBC and COAC classes.	29	633
SENIOR LEADER	The Senior Leader course, known as Toxic Agent Training, is conducted for personnel stationed at posts other than Ft. McClellan. The training is one day in duration, and culminates with live agent training.	20	824
USACMLS/ MISC	This course category includes military and civilian staff and cadre stationed at Ft. McClellan. These personnel attend training as part of professional development and to increase their understanding of training in a live agent environment.	25	1509

COURSE	PARTICIPANTS AND FOCUS	CLASSES	STUDENT
B-10	This course was conducted prior to OSUT. It has the same focus - to provide NBC specific training for newly enlisted soldiers.	188	5172
GERMANS	This course is taught to German Army and Air Force Officer and Enlisted personnel. These personnel are all chemical specialists. They require live agent training as part of their curriculum.	10	300
DESERT SHIELD	This course was taught specifically for units activated and deployed to support Desert Shield. It was attended primarily by reserve personnel.	7	361
JSOC	This course is taught to members of the Joint Special Operations Command. These personnel require live agent training as part of a diverse curriculum.	11	473
JAPANESE	This course was taught to officers of the Japanese Army Headquarters and to Japanese Chemical Officers. It focused on training in a live agent environment.	1	10
STATE DEPT	This course was taught to two different State Department groups. A Special Weapons and Tactics (SWAT) Team received live agent training because of their particular responsibilities. A group of treaty verification personnel received live agent training as part of their mission preparation.	2	38

3. As of 16 December, 1991, 668 classes with 19,810 students trained at the CDTF. The diverse groups attending the courses offered at the CDTF all had one need in common. They had the need to receive live agent training in the only facility of its kind - The Chemical Defense Training Facility.

APPENDIX K

Analysis of Senior Commander's Course Questionnaires

APPENDIX K

Analysis of Senior Commander's Course Questionnaire.

1. Attendees at the Senior Commander's course, which is designed for General officers and their primary staffs, also undergo training at the CDTF. For their course critique they complete receive a scaled response questionnaire with a scale from 0 - 3. A copy of the questionnaire is at Tab A.

2. The bar chart at Tab B shows the results of their course critique/questionnaire sheets for calendar year 1991. The bar chart shows the responses from approximately 165 officers and civilians from all branches of service and all components (National Guard, Reserves, Active and Civilian) for questions concerning survivability, confidence, credibility, and proficiency. The question for survivability (near the bottom, page two of the questionnaire) was scaled from 0 = No value to 3 = Great value. The question for confidence, credibility, and proficiency (question 8, page 3 of questionnaire) was scaled from 0 = Strongly disagree to 3 = Strongly agree.

3. As a whole, the senior leaders, seem to value the CDTF training as much as the more junior soldiers from the 24th ID. Because the results are so lopsided, we cannot draw many statistical inferences from the data. Using the chi-squared test we can show that the responses to the questions fall into two distinct groups. The responses to the survivability and confidence questions are similar, and the responses to the credibility and proficiency questions are similar. However, due to the low number of responses in the 0-2 range for the survivability and confidence questions, the results of the chi-squared test for this group are not reliable.

SENIOR COMMANDERS/CHEMICAL OFFICERS COURSE

18 -21 OCTOBER 1990

COURSE CRITIQUE AND SURVEY QUESTIONNAIRE

The Senior Commanders/Chemical Officers Course is modified for each iteration based heavily upon class suggestions and reactions. This information will help us to continue to improve the course. For this reason we thank you for your time and thought in preparing your responses to this critique.

Circle Appropriate Answer

1. UNIT/ORGANIZATION ASSIGNMENT

   a. Combat Arms
   b. Combat Support
   (c.) Combat Service Support
   d. Other

2. COMPONENT

   a. Active
   b. National Guard
   (c.) Reserve
   d. Civilian

3. BRANCH OF SERVICE

   (a.) Army
   b. Marine Corps
   c. Navy
   d. Air Force
   e. Other

4. GRADE OR EQUIVALENT

   (a.) O-7/SES and above
   b. O-6/GM-15
   c. O-5/GM-14 and below

TAB A

5. RATING FOR EACH BLOCK OF INSTRUCTION. Subject matter listed below concern the blocks of instruction in this course and its utility to you as a Senior Commander. Please rate each block of instruction in the following two areas:

a. Area one. Rate each block of instruction in terms of the degree you feel appropriate in preparing you for the Airland battle.

b. Area two. The subject matter covered in each block was adequate.

Possible Responses:
(circle one only)
3 - Great Value
2 - Some Value
1 - Little Value
Ø - No Value
N/A- Not Applicable

Possible responses:
(circle one only)
3 - Strongly agree
2 - Agree
1 - Little Value
Ø - No Value
N/A- Not Applicable

BLOCKS OF INSTRUCTION

(3) 2 1 Ø N/A	C/B Threat: Battle Analysis Iran-Iraq War Proliferation and Terrorism	3 (2) 1 Ø N/A	
3 (2) 1 Ø N/A	NBC Force Structure	3 (2) 1 Ø N/A	
(3) 2 1 Ø N/A	DA Perspectives and Priorities	(3) 2 1 Ø N/A	
3 (2) 1 Ø N/A	Current NBC Doctrine	3 (2) 1 Ø N/A	
(3) 2 1 Ø N/A	NBC Material Development	(3) 2 1 Ø N/A	
3 (2) 1 Ø N/A	NBC Individual/Collective Protective Developement	3 2 (1) Ø N/A	NEED SAMPLES
3 (2) 1 Ø N/A	Weapon System Vulnerability to Obscurrants	3 (2) 1 Ø N/A	
3 (2) 1 Ø N/A	NBC Training Devices and Simulations	3 (2) 1 Ø N/A	
(3) 2 1 Ø N/A	FORSCOM Overview	(3) 2 1 Ø N/A	WELL DONE
(3) 2 1 Ø N/A	Battlefield Obscurrants: Concept thru Execution; Demonstration	(3) 2 1 Ø N/A	
(3) 2 1 Ø N/A	Medical Aspects of NBC Defense	3 (2) 1 Ø N/A	
(3) 2 1 Ø N/A	Integrated Battlefield	(3) 2 1 Ø N/A	
3 (2) 1 Ø N/A	Fixed Site NBC Defense	3 (2) 1 Ø N/A	
(3) 2 1 Ø N/A	Survivability Skills and Decontamination w/live Chemical Agents (CDTF)	(3) 2 1 Ø N/A	
(3) 2 1 Ø N/A	CANE	(3) 2 1 Ø N/A	

The following rating system applies to questions 6 - 9.

3 - Strongly Agree
2 - Agree
1 - Disagree
0 - Strongly Disagree
N/A - Not Applicable

6. The smoke/flame demonstration was effective in reinforcing training:

a. Smoke/Obscurrant demonstration (3) 2 1 0

b. Smoke equipment display (3) 2 1 0

c. Electro/Optical Systems (3) 2 1 0

7. NBC training devices were effective in Reinforcing training.

(3) 2 1 0

8. The Chemical Decontamination Training Facility (CDTF) exercise was effective in reinforcing:

a. Confidence (3) 2 1 0

b. Credibility (3) 2 1 0

c. Proficiency (3) 2 1 0

Excellent Training Well done

9. The following portions of the Chemical Decontamination Training Facility (CDTF) were adequate:

a. Simulant Pad Training (3) 2 1 0

b. Toxic Agent Chamber (3) 2 1 0

c. Displays/Demonstrations (3) 2 1 0

d. Administration/Screening/Safety (3) 2 1 0

10. Will the handouts/training packets benefit your program?

(Yes) No - N/A

11. The following pertains to the administration portion of the course. Please select the appropriate answer.

Possible responses: 3 - Excellent
(circle only one) 2 - Good
1 - Fair
0 - Poor
N/A - Not Applicable

a. Inprocessing	(3)	2	1	0	N/A	
b. Accommodations	(3)	2	1	0	N/A	GREAT
c. Lunch Friday	(3)	2	1	0	N/A	
d. Supper Friday	(3)	2	1	0	N/A	
e. Lunch Saturday	(3)	2	1	0	N/A	
f. Classroom Refreshments	(3)	2	1	0	N/A	
g. Transportation	(3)	2	1	0	N/A	

12. What single idea or concept will you most remember from the course?

Hands on Training at the CBTF.
Excellent Instructors - Highly Motivated Instructors

13. Should additional subjects be added to the course? If yes please indicate your suggestions.

—

14. Should any courses be deleted from the course? If yes please indicate which subject(s).

—

COMMENTS :

ALL Commanders - Active - Guard + Reserve w/ Face possible deployment for Direct Shield of potential chemical environment should attend this course or at least go to the CBTF. I found the course to be excellent, the Instructors Great Role and Hospitality excellent.

Senior Commander's Course Questionnaire
CY 91 results